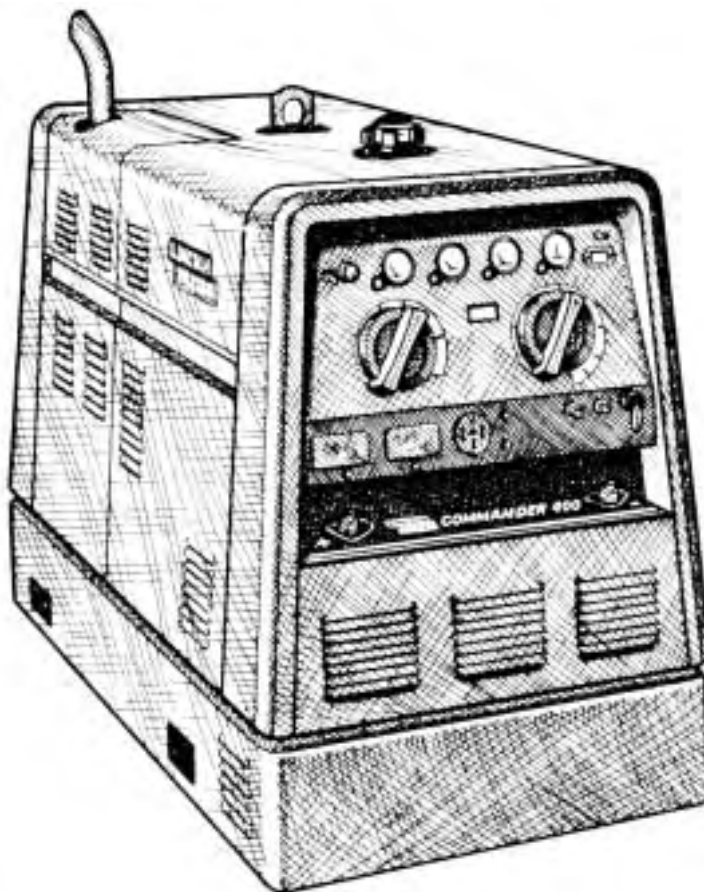


# Commander™ 400

For use with machine code numbers: 9978, 9979, 10580, 10581

## Safety Depends on You

Lincoln arc welding and cutting equipment is designed and built with safety in mind. However, your overall safety can be increased by proper installation . . . and thoughtful operation on your part. **DO NOT INSTALL, OPERATE OR REPAIR THIS EQUIPMENT WITHOUT READING THIS MANUAL AND THE SAFETY PRECAUTIONS CONTAINED THROUGHOUT.** And, most importantly, think before you act and be careful.



## SERVICE MANUAL

**LINCOLN®  
ELECTRIC**

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• World's Leader in Welding and Cutting Products •

• Sales and Service through Subsidiaries and Distributors Worldwide •

Cleveland, Ohio 44117-1199 U.S.A. TEL: 216.481.8100 FAX: 216.486.1751 WEB SITE: [www.lincolnelectric.com](http://www.lincolnelectric.com)



## WARNING



### CALIFORNIA PROPOSITION 65 WARNINGS



Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

The Above For Diesel Engines

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

The Above For Gasoline Engines

**ARC WELDING CAN BE HAZARDOUS. PROTECT YOURSELF AND OTHERS FROM POSSIBLE SERIOUS INJURY OR DEATH. KEEP CHILDREN AWAY. PACEMAKER WEARERS SHOULD CONSULT WITH THEIR DOCTOR BEFORE OPERATING.**

Read and understand the following safety highlights. For additional safety information, it is strongly recommended that you purchase a copy of "Safety in Welding & Cutting - ANSI Standard Z49.1" from the American Welding Society, P.O. Box 351040, Miami, Florida 33135 or CSA Standard W117.2-1974. A Free copy of "Arc Welding Safety" booklet E205 is available from the Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, Ohio 44117-1199.

**BE SURE THAT ALL INSTALLATION, OPERATION, MAINTENANCE AND REPAIR PROCEDURES ARE PERFORMED ONLY BY QUALIFIED INDIVIDUALS.**



### FOR ENGINE powered equipment.

1.a. Turn the engine off before troubleshooting and maintenance work unless the maintenance work requires it to be running.



1.b. Operate engines in open, well-ventilated areas or vent the engine exhaust fumes outdoors.



1.c. Do not add the fuel near an open flame welding arc or when the engine is running. Stop the engine and allow it to cool before refueling to prevent spilled fuel from vaporizing on contact with hot engine parts and igniting. Do not spill fuel when filling tank. If fuel is spilled, wipe it up and do not start engine until fumes have been eliminated.



1.d. Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing equipment.

1.e. In some cases it may be necessary to remove safety guards to perform required maintenance. Remove guards only when necessary and replace them when the maintenance requiring their removal is complete. Always use the greatest care when working near moving parts.

1.f. Do not put your hands near the engine fan. Do not attempt to override the governor or idler by pushing on the throttle control rods while the engine is running.

1.g. To prevent accidentally starting gasoline engines while turning the engine or welding generator during maintenance work, disconnect the spark plug wires, distributor cap or magneto wire as appropriate.



1.h. To avoid scalding, do not remove the radiator pressure cap when the engine is hot.



### ELECTRIC AND MAGNETIC FIELDS may be dangerous

2.a. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding current creates EMF fields around welding cables and welding machines

2.b. EMF fields may interfere with some pacemakers, and welders having a pacemaker should consult their physician before welding.

2.c. Exposure to EMF fields in welding may have other health effects which are now not known.

2.d. All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:

2.d.1. Route the electrode and work cables together - Secure them with tape when possible.

2.d.2. Never coil the electrode lead around your body.

2.d.3. Do not place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should also be on your right side.

2.d.4. Connect the work cable to the workpiece as close as possible to the area being welded.

2.d.5. Do not work next to welding power source.

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## ELECTRIC SHOCK can kill.

3.a. The electrode and work (or ground) circuits are electrically "hot" when the welder is on. Do not touch these "hot" parts with your bare skin or wet clothing. Wear dry, hole-free gloves to insulate hands.

3.b. Insulate yourself from work and ground using dry insulation. Make certain the insulation is large enough to cover your full area of physical contact with work and ground.

**In addition to the normal safety precautions, if welding must be performed under electrically hazardous conditions (in damp locations or while wearing wet clothing; on metal structures such as floors, gratings or scaffolds; when in cramped positions such as sitting, kneeling or lying, if there is a high risk of unavoidable or accidental contact with the workpiece or ground) use the following equipment:**

- Semiautomatic DC Constant Voltage (Wire) Welder.
- DC Manual (Stick) Welder.
- AC Welder with Reduced Voltage Control.

3.c. In semiautomatic or automatic wire welding, the electrode, electrode reel, welding head, nozzle or semiautomatic welding gun are also electrically "hot".

3.d. Always be sure the work cable makes a good electrical connection with the metal being welded. The connection should be as close as possible to the area being welded.

3.e. Ground the work or metal to be welded to a good electrical (earth) ground.

3.f. Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition. Replace damaged insulation.

3.g. Never dip the electrode in water for cooling.

3.h. Never simultaneously touch electrically "hot" parts of electrode holders connected to two welders because voltage between the two can be the total of the open circuit voltage of both welders.

3.i. When working above floor level, use a safety belt to protect yourself from a fall should you get a shock.

3.j. Also see Items 6.c. and 8.



## ARC RAYS can burn.

4.a. Use a shield with the proper filter and cover plates to protect your eyes from sparks and the rays of the arc when welding or observing open arc welding. Head shield and filter lens should conform to ANSI Z87.1 standards.

4.b. Use suitable clothing made from durable flame-resistant material to protect your skin and that of your helpers from the arc rays.

4.c. Protect other nearby personnel with suitable, non-flammable screening and/or warn them not to watch the arc nor expose themselves to the arc rays or to hot spatter or metal.



## FUMES AND GASES can be dangerous.

5.a. Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. When welding, keep your head out of the fume. Use enough ventilation and/or exhaust at the arc to keep

fumes and gases away from the breathing zone. **When welding with electrodes which require special ventilation such as stainless or hard facing (see instructions on container or MSDS) or on lead or cadmium plated steel and other metals or coatings which produce highly toxic fumes, keep exposure as low as possible and below Threshold Limit Values (TLV) using local exhaust or mechanical ventilation. In confined spaces or in some circumstances, outdoors, a respirator may be required. Additional precautions are also required when welding on galvanized steel.**

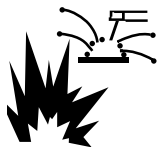
5.b. Do not weld in locations near chlorinated hydrocarbon vapors coming from degreasing, cleaning or spraying operations. The heat and rays of the arc can react with solvent vapors to form phosgene, a highly toxic gas, and other irritating products.

5.c. Shielding gases used for arc welding can displace air and cause injury or death. Always use enough ventilation, especially in confined areas, to insure breathing air is safe.

5.d. Read and understand the manufacturer's instructions for this equipment and the consumables to be used, including the material safety data sheet (MSDS) and follow your employer's safety practices. MSDS forms are available from your welding distributor or from the manufacturer.

5.e. Also see item 1.b.

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## WELDING SPARKS can cause fire or explosion.

6.a. Remove fire hazards from the welding area.

If this is not possible, cover them to prevent the welding sparks from starting a fire.

Remember that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas. Avoid welding near hydraulic lines. Have a fire extinguisher readily available.

6.b. Where compressed gases are to be used at the job site, special precautions should be used to prevent hazardous situations. Refer to "Safety in Welding and Cutting" (ANSI Standard Z49.1) and the operating information for the equipment being used.

6.c. When not welding, make certain no part of the electrode circuit is touching the work or ground. Accidental contact can cause overheating and create a fire hazard.

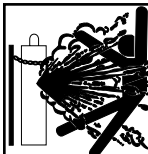
6.d. Do not heat, cut or weld tanks, drums or containers until the proper steps have been taken to insure that such procedures will not cause flammable or toxic vapors from substances inside. They can cause an explosion even though they have been "cleaned". For information, purchase "Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances", AWS F4.1 from the American Welding Society (see address above).

6.e. Vent hollow castings or containers before heating, cutting or welding. They may explode.

6.f. Sparks and spatter are thrown from the welding arc. Wear oil free protective garments such as leather gloves, heavy shirt, cuffless trousers, high shoes and a cap over your hair. Wear ear plugs when welding out of position or in confined places. Always wear safety glasses with side shields when in a welding area.

6.g. Connect the work cable to the work as close to the welding area as practical. Work cables connected to the building framework or other locations away from the welding area increase the possibility of the welding current passing through lifting chains, crane cables or other alternate circuits. This can create fire hazards or overheat lifting chains or cables until they fail.

6.h. Also see item 1.c.



## CYLINDER may explode if damaged.

7.a. Use only compressed gas cylinders containing the correct shielding gas for the process used and properly operating regulators designed for the gas and pressure used. All hoses, fittings, etc. should be suitable for the application and maintained in good condition.

7.b. Always keep cylinders in an upright position securely chained to an undercarriage or fixed support.

7.c. Cylinders should be located:

- Away from areas where they may be struck or subjected to physical damage.

- A safe distance from arc welding or cutting operations and any other source of heat, sparks, or flame.

7.d. Never allow the electrode, electrode holder or any other electrically "hot" parts to touch a cylinder.

7.e. Keep your head and face away from the cylinder valve outlet when opening the cylinder valve.

7.f. Valve protection caps should always be in place and hand tight except when the cylinder is in use or connected for use.

7.g. Read and follow the instructions on compressed gas cylinders, associated equipment, and CGA publication P-1, "Precautions for Safe Handling of Compressed Gases in Cylinders," available from the Compressed Gas Association 1235 Jefferson Davis Highway, Arlington, VA 22202.



## FOR ELECTRICALLY powered equipment.

8.a. Turn off input power using the disconnect switch at the fuse box before working on the equipment.

8.b. Install equipment in accordance with the U.S. National Electrical Code, all local codes and the manufacturer's recommendations.

8.c. Ground the equipment in accordance with the U.S. National Electrical Code and the manufacturer's recommendations.

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# SAFETY

## PRÉCAUTIONS DE SÛRETÉ

Pour votre propre protection lire et observer toutes les instructions et les précautions de sûreté spécifiques qui paraissent dans ce manuel aussi bien que les précautions de sûreté générales suivantes:

### Sûreté Pour Soudage A L'Arc

1. Protégez-vous contre la secousse électrique:
  - a. Les circuits à l'électrode et à la pièce sont sous tension quand la machine à souder est en marche. Eviter toujours tout contact entre les parties sous tension et la peau nue ou les vêtements mouillés. Porter des gants secs et sans trous pour isoler les mains.
  - b. Faire très attention de bien s'isoler de la masse quand on soude dans des endroits humides, ou sur un plancher métallique ou des grilles métalliques, principalement dans les positions assis ou couché pour lesquelles une grande partie du corps peut être en contact avec la masse.
  - c. Maintenir le porte-électrode, la pince de masse, le câble de soudage et la machine à souder en bon et sûr état de fonctionnement.
  - d. Ne jamais plonger le porte-électrode dans l'eau pour le refroidir.
  - e. Ne jamais toucher simultanément les parties sous tension des porte-électrodes connectés à deux machines à souder parce que la tension entre les deux pinces peut être le total de la tension à vide des deux machines.
  - f. Si on utilise la machine à souder comme une source de courant pour soudage semi-automatique, ces précautions pour le porte-électrode s'appliquent aussi au pistolet de soudage.
2. Dans le cas de travail au dessus du niveau du sol, se protéger contre les chutes dans le cas où on recoit un choc. Ne jamais enrouler le câble-électrode autour de n'importe quelle partie du corps.
3. Un coup d'arc peut être plus sévère qu'un coup de soliel, donc:
  - a. Utiliser un bon masque avec un verre filtrant approprié ainsi qu'un verre blanc afin de se protéger les yeux du rayonnement de l'arc et des projections quand on soude ou quand on regarde l'arc.
  - b. Porter des vêtements convenables afin de protéger la peau de soudeur et des aides contre le rayonnement de l'arc.
  - c. Protéger l'autre personnel travaillant à proximité au soudage à l'aide d'écrans appropriés et non-inflammables.
4. Des gouttes de laitier en fusion sont émises de l'arc de soudage. Se protéger avec des vêtements de protection libres de l'huile, tels que les gants en cuir, chemise épaisse, pantalons sans revers, et chaussures montantes.
5. Toujours porter des lunettes de sécurité dans la zone de soudage. Utiliser des lunettes avec écrans latéraux dans les

zones où l'on pique le laitier.

6. Eloigner les matériaux inflammables ou les recouvrir afin de prévenir tout risque d'incendie dû aux étincelles.
7. Quand on ne soude pas, poser la pince à un endroit isolé de la masse. Un court-circuit accidentel peut provoquer un échauffement et un risque d'incendie.
8. S'assurer que la masse est connectée le plus près possible de la zone de travail qu'il est pratique de le faire. Si on place la masse sur la charpente de la construction ou d'autres endroits éloignés de la zone de travail, on augmente le risque de voir passer le courant de soudage par les chaînes de levage, câbles de grue, ou autres circuits. Cela peut provoquer des risques d'incendie ou d'échauffement des chaînes et des câbles jusqu'à ce qu'ils se rompent.
9. Assurer une ventilation suffisante dans la zone de soudage. Ceci est particulièrement important pour le soudage de tôles galvanisées plombées, ou cadmiées ou tout autre métal qui produit des fumées toxiques.
10. Ne pas souder en présence de vapeurs de chlore provenant d'opérations de dégraissage, nettoyage ou pistolage. La chaleur ou les rayons de l'arc peuvent réagir avec les vapeurs du solvant pour produire du phosgène (gas fortement toxique) ou autres produits irritants.
11. Pour obtenir de plus amples renseignements sur la sûreté, voir le code "Code for safety in welding and cutting" CSA Standard W 117.2-1974.

## PRÉCAUTIONS DE SÛRETÉ POUR LES MACHINES À SOUDER À TRANSFORMATEUR ET À REDRESSEUR

1. Relier à la terre le châssis du poste conformément au code de l'électricité et aux recommandations du fabricant. Le dispositif de montage ou la pièce à souder doit être branché à une bonne mise à la terre.
2. Autant que possible, l'installation et l'entretien du poste seront effectués par un électricien qualifié.
3. Avant de faire des travaux à l'intérieur de poste, la débrancher à l'interrupteur à la boîte de fusibles.
4. Garder tous les couvercles et dispositifs de sûreté à leur place.

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### Installation

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# INSTALLATION

## TECHNICAL SPECIFICATIONS - Commander 400

INPUT - DIESEL ENGINE					
Make/Model	Description	Speed (RPM)	Displacement	Starting System	Capacities
Deutz F3L 912 Diesel Engine	3 cylinder 44.2 HP(33kw) @ 1800 RPM	High Idle 1900 Low Idle 1350 Full Load 1800	173 cu. in (2.827 L)	12VDC battery & Starter	Fuel: 25 gal. 94.6 L
			<b>Bore x Stroke</b>  3.94" x 4.72" (100mm x 120mm)		Oil: 8.5 Qts. 8.04 L
RATED OUTPUT - WELDER					
Duty Cycle	Welding Output			Volts at Rated Amps	
100%	400 amps (DC Constant Current) 400 amps (DC Constant Voltage)			40 volts 40 volts	
60%	500 amps (DC Constant Current) 500 amps (DC Constant Voltage)			40 volts 40 volts	
OUTPUT - WELDER AND GENERATOR					
Welding Range		Open Circuit Voltage		Auxiliary Power¹	
40 - 575 Amps in 7 Ranges (Stick model) or 8 Ranges (Stick & Wire model)		64-74 OCV  @1915 RPM		120/240 VAC 10,000 Watts, 60 Hz. 100% Duty Cycle	
PHYSICAL DIMENSIONS					
HEIGHT²	WIDTH		DEPTH		WEIGHT
42.0 in.	31.5 in.		63.1 in.		1650 lbs.(748 kg) (Stick model)
1066.8 mm	800.1 mm		1602.7 mm		1683 lbs.(763 kg) (Stick & Wire model)

1. Output rating in watts is equivalent to volt-amperes at unity power factor.

Output voltage is within +/- 10% at all loads up to rated capacity. When welding, available auxiliary power will be reduced.

2. Top of Enclosure. Add 6.64" (168.7mm) for exhaust.

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# INSTALLATION

Read this entire installation section before you start installation.

## SAFETY PRECAUTIONS

### ⚠ WARNING

Do not attempt to use this equipment until you have thoroughly read all the operation and maintenance manuals supplied with your machine. They include important safety precautions; detailed engine starting, operating and maintenance instructions and parts lists.

#### ELECTRIC SHOCK can kill.



- Do not touch electrically live parts such as output terminals or internal wiring.
- Insulate yourself from the work and ground.
- Always wear dry insulating gloves.

#### ENGINE EXHAUST can kill.



- Use in open, well ventilated areas or vent exhaust outside.
- Do not stack anything near the engine.

#### MOVING PARTS can injure.



- Do not operate with doors open or guards off.
- Stop the engine before servicing.
- Keep away from moving parts.

See additional safety information at the front of this manual.

**Only qualified personnel should install, use, or service this equipment.**

## LOCATION AND VENTILATION

The welder should be located to provide an unrestricted flow of clean, cool air to the cooling air inlets and to avoid restricting the cooling air outlets. Also, locate the welder so that the engine exhaust fumes are properly vented to an outside area.

## STORING

1. Store the machine in a cool, dry place when it is not in use. Protect it from dust and dirt. Keep it where it can't be accidentally damaged from construction activities, moving vehicles, and other hazards.
2. Drain the engine oil and refill with fresh 10W30 oil. Run the engine for about five minutes to circulate oil to all the parts. See the **Maintenance** section of this manual for details on changing oil.
3. Remove the battery, recharge it, and adjust the electrolyte level. Store the battery in a dry, dark place.
4. See your engine operation manual for further information on fuel and engine preservation.

## STACKING

Commander 400 machines CANNOT be stacked.

## ANGLE OF OPERATION

To achieve optimum engine performance the Commander 400 should be run in a level position. The maximum angle of operation for the Deutz engine is 20 degrees in a direction to cause the control panel to be angled up, 30 degrees for side to side tilting and for the control panel to be angled down. If the engine is to be operated at an angle, provisions must be made for checking and maintaining the oil level at the normal (FULL) oil capacity in the crankcase. When operating the welder at an angle, the effective fuel capacity will be slightly less than the specified 25 gallons.

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# INSTALLATION

## LIFTING

The Commander 400 weighs 1650 lb./748 kg (Stick model); 1683 lb./763 kg. (Stick & Wire model). A lift bail is provided for lifting with a hoist.

### ⚠ WARNING

#### FALLING EQUIPMENT can cause injury.



Do not lift this machine using lift bail if it is equipped with a heavy accessory such as a trailer.

Lift only with equipment of adequate lifting capacity. Be sure machine is stable when lifting.

The Commander is shipped with the lift bail retracted. Before attempting to lift the Commander, secure the lift bail in a raised position. Secure the lift bail as follows:

- Open the engine compartment door.
- Locate the 2 access holes on the upper middle region of compartment wall just below the lift bail.
- Use the lifting strap to raise the lift bail to the full upright position. This will align the mounting holes on the lift bail with the access holes.
- Secure the lift bail with 2 thread forming screws. The screws are provided in the shipped loose parts bag.

## HIGH ALTITUDE OPERATION

At higher altitudes, output derating may be necessary. Some engine adjustments may be required. Contact a Deutz Service Representative.

## TOWING

The recommended trailer for use with this equipment for road, in-plant and yard towing by a vehicle<sup>(1)</sup> is Lincoln's K953-1. If the user adapts a non-Lincoln trailer, he must assume responsibility that the method of attachment and usage does not result in a safety hazard nor damage the welding equipment. Some of the factors to consider are as follows:

- Design capacity of trailer vs. the weight of the Lincoln equipment and likely additional attachments.
- Proper support of, and attachment to, the base of the welding equipment so that there will be no undue stress to the trailer's framework.

- Proper placement of the equipment on the trailer to insure stability side to side and front to back when the trailer is being moved and when standing by itself.
- Typical conditions of use, such as travel speed, roughness of surface on which the trailer will be operated, environmental conditions, and likely maintenance.
- Proper preventative maintenance of trailer.
- Conformance with federal, state and local laws.<sup>1</sup>

<sup>1</sup> Consult applicable federal, state and local laws regarding specific requirements for use on public highways.

## PRE-OPERATION ENGINE SERVICE

Read and understand the information about the diesel engine in the **Operation** and **Maintenance** sections of this manual before you operate the Commander 400.

### ⚠ WARNING

- Stop the engine and allow it to cool before fueling.
- Do not smoke when fueling.



- Fill the fuel tank at a moderate rate and do not overfill.
- Wipe up spilled fuel and allow the fumes to clear before starting the engine.

- Keep sparks and flame away from the tank.



**OIL**

The Commander 400 is shipped with the engine filled with SAE 10W-30 oil (API class CD or better). This should be fine for most ambient operating temperature conditions. See the engine operation manual for specific recommendations. **CHECK THE OIL LEVEL BEFORE YOU START THE ENGINE.** This is an added precaution. When full, the oil level should be up to but not over the FULL mark on the dipstick. If it is not full, add enough oil to fill it to the full mark. DO NOT overfill.

Check oil level after every 4 hours of running time during the first 35 hours of operation.

**NOTE:** This machine is equipped with an engine protection package. An internal kill switch will shut down the engine if the oil pressure drops below a minimum level or if oil temperature becomes excessive.

**For more oil fill and service information, see the Maintenance section of this manual.**

COMMANDER 400



## INSTALLATION



## FUEL

**NOTE:** Use diesel fuel only.

Fill the fuel tank with clean, fresh diesel fuel. The capacity of the fuel tank is 25 gallons (94.6 liters). See the **Operation** and **Maintenance** sections of this manual for more details about fuel.

The Commander 400 is protected by a low fuel shutdown to prevent the engine from running out of fuel. The machine will indicate a low fuel condition by turning on the low fuel light. A time of 30 minutes will elapse once the low fuel light illuminates before the machine will shutdown. A restart of the machine will restart the timer to allow the operator to override this feature. The amount of reserve fuel remaining in the tank after the first shutdown will vary from machine to machine. The operator must determine the amount of fuel remaining before re-starting the machine. **Running out of fuel may require bleeding the fuel injection pump.**

**NOTE:** Before starting the engine, open the fuel shut-off valve (lever to be in line with hose) located on the side of the fuel pre-filter/water separator housing.

## FUEL CAP

Remove the plastic cap covering the fuel tank filler neck and install the fuel cap.

## COOLING SYSTEM

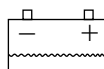
The Deutz engine is air cooled by a belt driven axial blower. The oil cooler and engine cooling fins should be blown out with compressed air or steam to maintain proper cooling (See the engine owner's manual for procedures and frequency).

## BATTERY CONNECTIONS

**⚠ WARNING**

**BATTERY ACID CAN BURN EYES AND SKIN.**

- Wear gloves and eye protection and be careful when working near a battery, follow the instructions printed on the battery.



The Commander 400 is shipped with the negative battery cable disconnected. Before you operate the machine, make sure the IGNITION switch is in the OFF position and attach the disconnected cable securely to the battery terminal. If the battery is discharged and won't start the engine, see the battery charging instructions in the **Maintenance** section.

## MUFFLER OUTLET PIPE

Remove the plastic plug covering the muffler outlet tube. Using the clamp provided secure the outlet pipe to the outlet tube with the pipe positioned such that it will direct the exhaust in the desired direction.

## SPARK ARRESTER

Diesel engine mufflers may emit sparks when the engine is running. Some federal, state, or local laws require spark arresters in locations where unarrested sparks could present a fire hazard.

Standard mufflers (like the one included with the Commander 400) do not act as spark arresters. When local laws require it, a spark arrester must be installed on the machine and properly maintained. An optional spark arrester kit is available for your Commander 400. See the **Accessories** section of this manual for more information.

**⚠ CAUTION**

An incorrect arrester may lead to damage to the engine or adversely affect performance.

COMMANDER 400



## ELECTRICAL OUTPUT CONNECTIONS

See Figure A.1 for the location of the 120 and 240 volt receptacles, weld output terminals, and ground stud.

## WELDING CABLE CONNECTIONS

### CABLE INSTALLATION AND CABLE SIZES

With the engine off, route the electrode and work cables through the strain relief bracket on the base and connect to the terminals located on the fuel tank mounting rail. (See size recommendations below.) For positive polarity, connect the electrode cable to the terminal marked Positive (+). For Negative polarity, connect the electrode cable to the Negative (-) terminal. These connections should be checked periodically and tightened if necessary.

⚠ CAUTION

- Loose connections will cause the output terminals to overheat. The terminals may eventually melt.
- Do not cross the welding cables at the output terminal connection. Keep the cables isolated and separate from one another.

When welding at a considerable distance from the welder, be sure you use ample size welding cables. Table A.1 lists recommended cable sizes and lengths for rated current and duty cycle. Length refers to the distance from the welder to the work and back to the welder. Cable diameters are increased for long cable lengths to reduce voltage drops.

Lincoln Electric offers a welding accessory kit with the properly specified welding cables. See the **Accessories** section of this manual for more information.

FIGURE A.1 - COMMANDER 400 OUTPUT CONNECTIONS

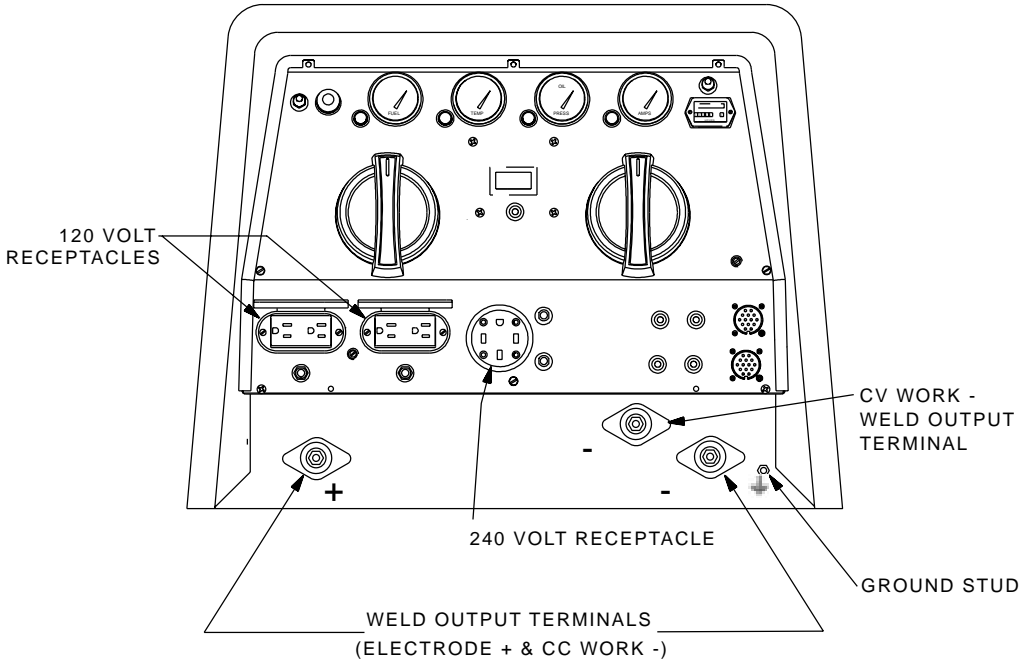


TABLE A.1 - RECOMMENDED COPPER WELDING CABLE SIZE AND LENGTH  
TOTAL COMBINED LENGTH OF ELECTRODE AND WORK CABLES

		Cable sizes for combined length of electrode plus work cable	
Amps	Duty Cycle	Up to 200 ft.	200 to 250 ft.
250	100%	1 AWG	1/0 AWG
400	100%	3/0 AWG	4/0 AWG

COMMANDER 400



# INSTALLATION

## MACHINE GROUNDING

Because this portable engine driven welder creates its own power, it is not necessary to connect its frame to an earth ground, unless the machine is connected to premises wiring (home, shop, etc.).


To prevent dangerous electric shock, other equipment powered by this engine driven welder must:

- a) be grounded to the frame of the welder using a grounded type plug,

or

- b) be double insulated.

When this welder is mounted on a truck or trailer, its frame must be securely connected to the metal frame of the vehicle. When connected to premises wiring such as that in a home or shop, its frame must be connected to the system earth ground. See further connection instructions in the section "Standby Power Connections" as well as the article on grounding in the latest U.S. National Electrical Code and the local code.

In general, if the machine is to be grounded, it should be connected with a #8 or larger copper wire to a solid earth ground such as a metal water pipe going into the ground for at least ten feet and having no insulated joints or to the metal framework of a building that has been effectively grounded. The U.S. National Electrical Code lists a number of alternate means of grounding electrical equipment. A machine grounding stud marked with the  symbol is provided on the front of the welder.

## AUXILIARY POWER RECEPTACLES

The Commander 400 can produce 10,000 watts of 60 Hz, single-phase auxiliary power. (The rating in watts is equivalent to volt-amperes at unity power factor.) The output voltage is within  $\pm 10\%$  at all loads up to the rated capacity.

The following receptacles are provided:

- Two 15 amp-120VAC duplex GFCI receptacles (5-15R)
- One 50 amp-120/240VAC receptacle (14-50R)

The 50 amp receptacle has a maximum permissible output of 44 amps. However, it can be split to power two separate, single-phase 120VAC branch circuits each capable of 44 amps output.

**NOTE:** The two 120VAC outlets of the 120/240VAC receptacle cannot be paralleled. They are on two different phases.

The auxiliary power receptacles should be used with only three-wire, grounded type plugs or approved double-insulated tools with two-wire plugs. The current rating of any plug used with the system must be at least equal to the current-carrying capacity of the associated receptacle. An optional power plug kit is available. See the **Accessories** section.

## STANDBY POWER CONNECTIONS

The Commander 400 is suitable for temporary, standby or emergency power using the engine manufacturer's recommended maintenance schedule.

The Commander 400 can be permanently installed as a standby power unit for 240 volt 3-wire, 44 ampere service. Connections must be made by a licensed electrician who can determine how the 120/240 VAC power can be adapted to the particular installation and comply with all applicable electrical codes. The following information can be used as a guide by the electrician for most applications. Refer to the connection diagram shown in **Figure A.2**.

1. Install the double-pole, double-throw switch between the power company meter and the premises disconnect.

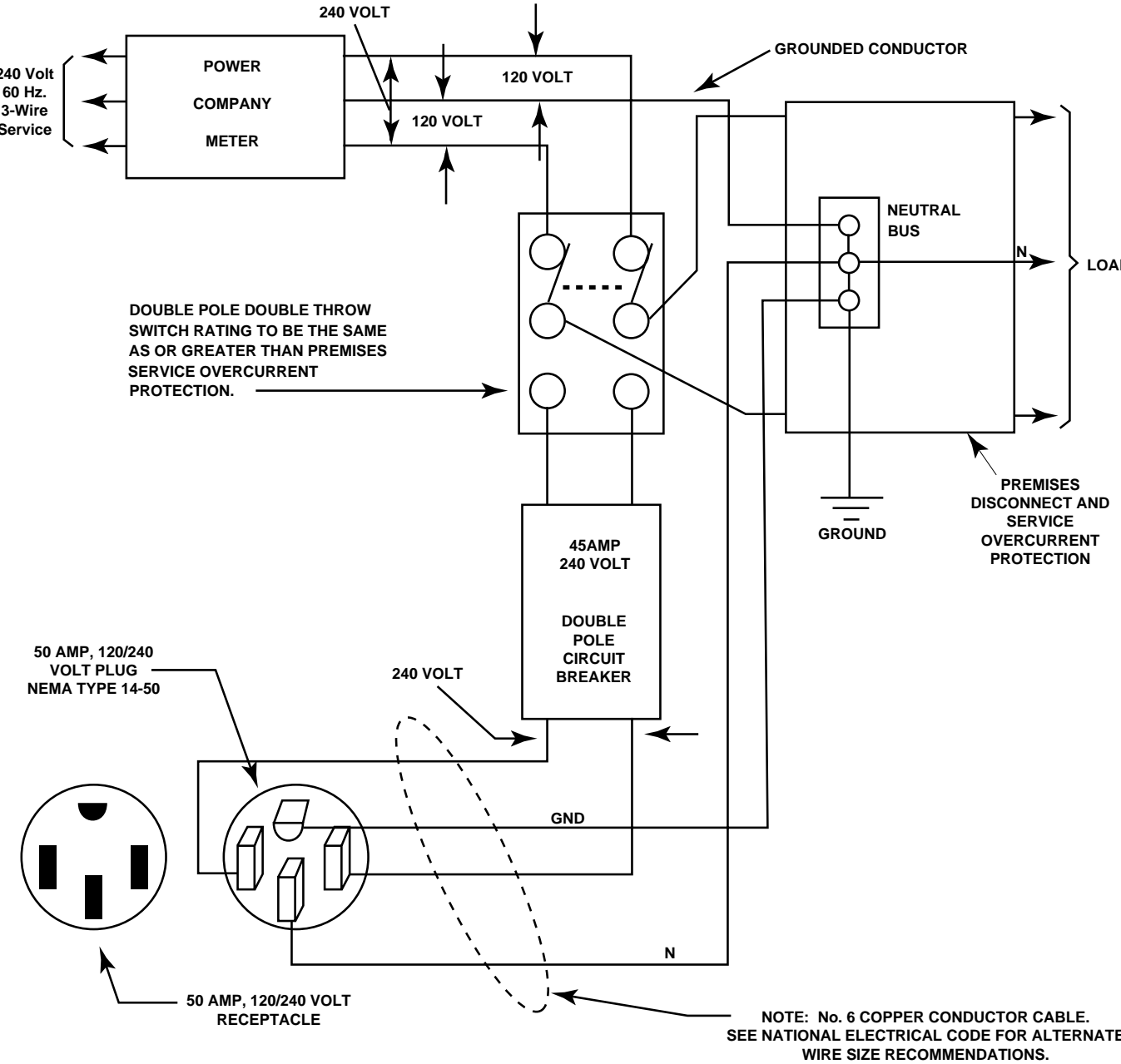
The switch rating must be the same or greater than the customer's premises disconnect and service over current protection.

2. Take the necessary steps to assure the load is limited to the capacity of the Commander 400 by installing a 45 amp, 240 VAC double-pole circuit breaker. Maximum rated load for each leg of the 240 VAC auxiliary is 45 amperes. Loading above the rated output will reduce output voltage below the allowable -10% of rated voltage, which may damage appliances or other motor-driven equipment and may result in overheating of the Commander 400 engine.
3. Install a 50 amp 120/240 VAC plug (NEMA Type 14-50) to the double-pole circuit breaker using No. 6, 4 conductor cable of the desired length. (The 50 amp, 120/240 VAC plug is available in the optional K802R plug kit.) See the **Accessories** section.
4. Plug this cable into the 50 ampere 120/240 volt receptacle on the Commander 400 case front.

COMMANDER 400



FIGURE A.2 - CONNECTION OF THE COMMANDER 400 TO PREMISES WIRING





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# OPERATION

## OPERATING INSTRUCTIONS

Read and understand this entire section before operating your Commander 400.

## SAFETY INSTRUCTIONS

### ⚠ WARNING

Do not attempt to use this equipment until you have thoroughly read all the operating and maintenance manuals supplied with your machine. They include important safety precautions; detailed engine starting, operating and maintenance instructions and parts lists.

### ELECTRIC SHOCK can kill.



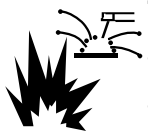
- Do not touch electrically live parts or electrodes with your skin or wet clothing.
- Insulate yourself from the work and ground.
- Always wear dry insulating gloves.

### FUMES AND GASES can be dangerous.



- Keep your head out of fumes.
- Use ventilation or exhaust to remove fumes from breathing zone.

### WELDING SPARKS can cause fire or explosion.



- Keep flammable material away.
- Do not weld on containers that have held combustibles.

### ARC RAYS can burn.



- Wear eye, ear, and body protection.

### ⚠ WARNING

### ENGINE EXHAUST can kill.



- Use in open, well ventilated areas or vent exhaust to the outside.
- Do not stack anything on or near the engine.

### MOVING PARTS can injure.



- Do not operate this equipment with any of its doors open or guards off.
- Stop the engine before servicing it.
- Keep away from moving parts.

Only qualified personnel should install, use, or service this equipment.

## GENERAL DESCRIPTION

The Commander 400 is a diesel engine driven welding power source. The machine uses a brushless asynchronous alternating current generator for DC stick electrode welding and for 120/240 VAC auxiliary standby power. As a generator it can supply up to 10,000 watts of 120/240 volt AC power. As a welder it provides up to 400 amps of DC constant current output in six slope-controlled ranges. In addition a seventh general purpose welding range provides up to 575 amps of constant current welding output.

The engine is a 44.2 Hp (33kw), 3-cylinder air/oil cooled diesel made by Deutz. This naturally aspirated, 4 cycle engine features direct injection, a Bosch in-line injection pump and a Bosch mechanical governor.

This machine is controlled by a high quality microcontroller. The microcontroller provides high speed control of the weld process as well as the engine protection features.

COMMANDER 400



# OPERATION

## RECOMMENDED APPLICATIONS

### WELDER

The Commander 400 (Stick model) provides excellent constant current DC welding output for stick (SMAW) welding. The Commander 400 (Stick & Wire model) also provides excellent constant voltage DC welding output for MIG (GMAW) and Inner shield (FCAW) welding.

### GENERATOR

The Commander 400 provides smooth 120/240 VAC output for auxiliary power and emergency standby power.

## DESIGN FEATURES

(All Models)

### FOR STICK WELDING

- Excellent DC constant current output for stick welding applications.
- 40 to 400 amps output in six slope controlled ranges for out-of position and pipe electrodes; 50 to 575 amps constant current output in one general purpose welding range.
- 3 digit display is provided for presetting the weld amperage and displaying the actual amperage during welding. The display uses super brite LEDs for improved readability in full sunlight.
- Remote control capability standard on all models.
- Selection of "hot" or "cold" output terminals with a toggle switch on the control panel. This feature can also be controlled by installing a remote output terminal control cable designed to open and close the #2 and #4 leads in the amphenol receptacle.

### FOR AUXILIARY POWER

- 10,000 watts of 120/240 VAC, 60Hz auxiliary power.
- Will drive a 2 HP motor (provided it is started under no load).
- Two 15 amp 120 VAC duplex receptacles with GFCI protection for up to 30 amps of 120 VAC power.

- One 50 amp, 120/240 VAC dual voltage receptacle for up to 44 amps of 240 VAC, and up to 44 amps per side to separate branch circuits (not in parallel) of 120 VAC single phase auxiliary power. Allows easy connection to premises wiring.
- Weld and AC auxiliary power at the same time (within machine total capacity).

### OTHER FEATURES

- Deutz 3-cylinder, air/oil cooled diesel engine. Designed for long life, easy maintenance and excellent fuel economy.
- Engine protection system shuts the engine down for low oil pressure, high oil temperature or a broken fan/engine alternator belt.
- Gauges for oil pressure, oil temperature, engine alternator output and fuel level.
- Indicator lights for low oil pressure, high oil temperature, engine alternator low output/broken belt and low fuel level.
- Automatic low fuel shutdown before running out of fuel.
- Engine hour meter standard on all models.
- Extended range 25 gallon (94.6 l) fuel tank.
- Fuel pre-filter/water separator with "dry" change element.
- Automatic idler reduces engine speed when not welding or drawing auxiliary power. This feature reduces fuel consumption and extends engine life.
- Single side engine service with over the top access to the engine.
- Copper alternator windings and high temperature insulation for dependability and long life.

COMMANDER 400



OPERATION

ADDITIONAL DESIGN FEATURES

(Stick & Wire Model only)

FOR WIRE WELDING

- One constant voltage position for all wire welding. A 12 to 45V range across the entire current output range.
- Excellent arc characteristics with MIG (GMAW) and Inner shield (FCAW) welding.
- A Wire Feeder connector for quick connection of the control cable.
- A built in “Electronic Contactor” for “Cold” electrode when not welding.
- The 3 digit display has the additional feature of pre-setting the open circuit voltage and displaying the actual voltage during welding.
- Designed for use with the following Lincoln wire feeders.
  - LN-25                      •LN-23P                      •LN-7
  - LN-8                      •NA-3                      •Spool Gun & K488 Module

WELDING CAPABILITY

The Commander 400 is rated at 400 amps, 40 volts at 100% duty cycle. The weld current is variable from 40 to 575 amps.

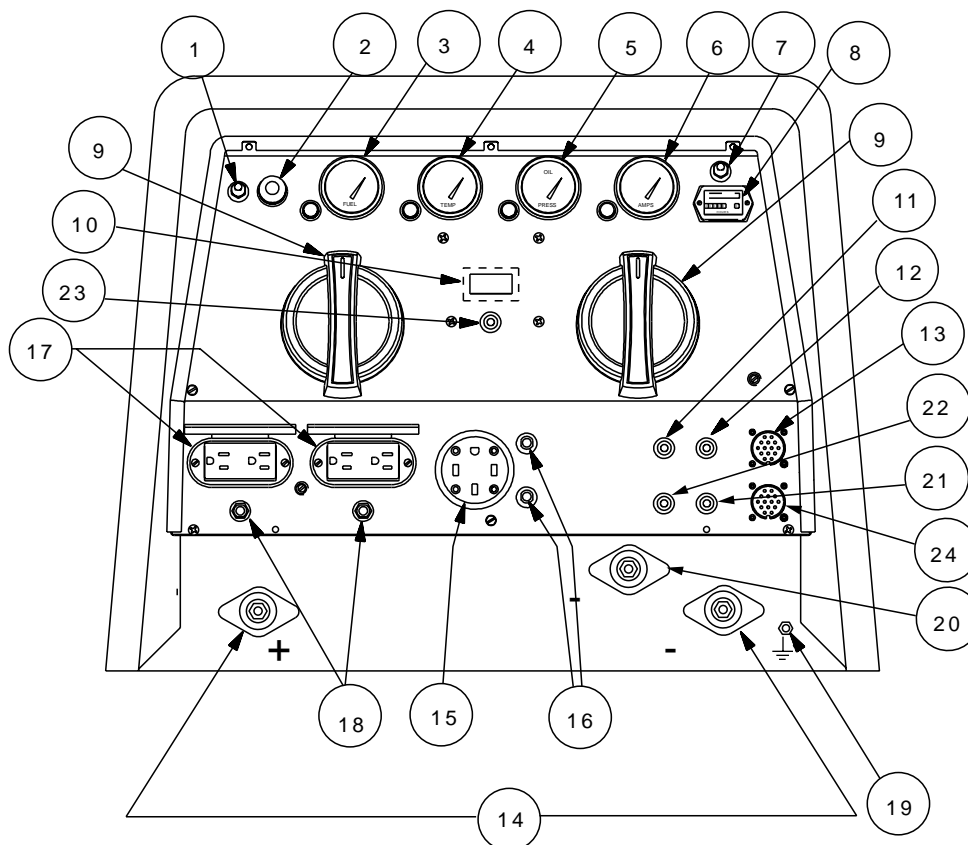


# OPERATION

## CONTROLS AND SETTINGS

The welder/generator controls are located on the case front panel. Refer to Figure B.1 and the explanations that follow.

FIGURE B.1 – CASE FRONT PANEL CONTROLS



## ENGINE CONTROLS

(Figure B.1, Items 1 through 8)

See Figure B.1 for the location of the following features:

1. **RUN-STOP SWITCH:** When placed in the “RUN” position, this switch energizes the fuel solenoid and other electric accessories. When placed in the “STOP” position, the flow of fuel to the injection pump is stopped to shut down the engine.

**NOTE:** If the switch is left in the “RUN” position and the engine is not running, the battery will be drained by the fuel solenoid.

2. **START PUSHBUTTON:** Energizes the starter motor to crank the engine. With the engine RUN-STOP switch in the “RUN” position, push and hold the START button for a minimum of 2 seconds to crank the engine; release as the engine starts. Do not press while engine is running since this can cause damage to the ring gear and/or starter motor.

3. **FUEL LEVEL GAUGE AND LIGHT:** Displays the level of diesel fuel in the 25-gallon (94.6 liter) fuel tank. The yellow light turns on when the fuel gage reaches the reserve level. Once the reserve level is reached, the engine protection system will shut down the engine after 30 minutes of operation. The machine can be restarted and operated for an additional 30 minutes before the protection system will shut down the engine. This ability to override the engine protection is to allow the operator to “finish up” if necessary. The operator must watch the fuel level closely to prevent running out of fuel and having to bleed the system.

COMMANDER 400



# OPERATION

## 4. ENGINE TEMPERATURE GAUGE AND LIGHT:

The gauge displays the engine oil temperature. The yellow temperature light remains off under normal operating temperatures. If the light turns on, the engine protection system will shut down the engine. Check for restrictions at the engine cooling air inlets and outlets (consult the engine Operation manual). Check for loose or disconnected leads at the temperature sender located on the engine. Check engine cooling blower belt. Also, check to be sure that the welder loads are within the rating of the welder. The light will remain on when the engine has been shut down due to an over-temperature condition.

## 5. OIL PRESSURE GAUGE AND LIGHT:

The gauge displays the engine oil pressure when the engine is running. The yellow oil pressure light remains off with proper oil pressure. If the light turns on, the engine protection system will stop the engine. Check for proper oil level and add oil if necessary. Check for loose or disconnected leads at the oil pressure sender located on the engine. The light will go on and stay on when the RUN-STOP switch is switched to the "RUN" position with the engine not running.

## 6. ENGINE ALTERNATOR AMMETER AND LIGHT:

The yellow engine alternator light is off when the battery charging system is functioning normally. If the light turns on, the engine protection system will shut down the engine. Check the engine cooling blower belt. Also, the alternator or the voltage regulator may not be operating correctly. The light may also come on if the alternator did not flash up due to not holding the start button in long enough (minimum of 2 seconds) or due to a faulty flashing circuit. The light will remain on when the engine has been shut down due to a fault in the alternator, regulator, or the cooling blower belt.

## 7. IDLER SWITCH:

Adjusts the running speed of the engine. Has two positions as follows:

A) In the "High" position, the engine runs at the high idle speed controlled by the governor.

B) In the "Auto" position, the idler operates as follows:

- a. When switched from "HIGH" to "AUTO" or after starting the engine, the engine will operate at full speed for approximately 15 seconds and then go to low idle speed.

- b. When the electrode touches the work or power is drawn for lights or tools (approximately 100 Watts minimum), the engine accelerates and operates at full speed.

- c. When welding ceases or the AC power load is turned off, a fixed time delay of approximately 15 seconds starts.

- d. If the welding or AC power load is not restarted before the end of the time delay, the idler reduces the engine speed to low idle speed.

- e. The engine will automatically return to high idle speed when the welding load or AC power load is reapplied.

## Idler Operational Exceptions

When the WELDING TERMINALS switch is in the "WELDING TERMINALS REMOTELY CONTROLLED" position, the idler will operate as follows:

- a. When the triggering device (Amptrol, Arc Start Switch, etc.) is pressed, the engine will accelerate and operate at full speed provided a welding load is applied within approximately 15 seconds.

- If the triggering device remains pressed but no welding load is applied, within approximately 15 seconds the engine will return to low idle speed.

- If the triggering device is released or welding ceases, the engine will return to low idle speed after approximately 15 seconds.

8. **HOOR METER:** The hour meter displays the total time that the engine has been running. This meter is a useful indicator for scheduling preventive maintenance.





# OPERATION

**WELDER CONTROLS** (Figure B.1 Items 9 through 14 )

9. **OUTPUT RANGE SWITCH AND OUTPUT CONTROL:** These two controls allow you to select between various welding output slopes and adjust the desired welding output. Refer to Table B.1 for a description of how these two controls work.

**TABLE B.1 OUTPUT RANGE SWITCH AND OUTPUT CONTROL FUNCTIONS**

	 Range Switch <sup>1</sup>	 Control <sup>2</sup>
Sloped Output for Pipe Welding. (all models)	6 Range Settings 90, 120, 180, 230, 270, 400 (Max. current on each setting)	Provides a fine adjustment of welding current or voltage from Min (1) to Max (10) within each range
Constant Current Output for Fabrication and General Purpose Welding (This setting also used for TIG) (all models)	1 Range setting 50-575 Amps	
Constant Voltage Output for Wire Welding (Stick & Wire model only)	1 Range setting 12 to 40 Volts	

<sup>1</sup> If the OUTPUT RANGE switch is positioned between settings, the previous setting is maintained until the switch is properly positioned on a setting.

<sup>2</sup> The OUTPUT CONTROL also controls O.C.V. while in the 6 sloped output ranges.

10. **DIGITAL OUTPUT METER:** The digital output meter is located in the center of the control panel between the two large control knobs. The meter allows the output current level to be set prior to welding. During the welding process the meter displays the actual output current.
11. **WELDING TERMINALS SWITCH:** The toggle switch on the control panel labeled “WELDING TERMINALS ALWAYS ON” and “WELDING TERMINALS REMOTELY CONTROLLED,” is used to control the operation of the “solid state contactor,” which allows for the selection of “Hot” or “Cold” welding terminals.

With the switch in the “WELDING TERMINALS ALWAYS ON” position, the contactor is closed and the welding terminals are always “Hot.”

With the switch in the “WELDING TERMINALS REMOTELY CONTROLLED” position, the contactor operation is controlled by an Amptrol, Arc Start Switch or some other type of triggering device through the use of a control cable connected to the 6-pin MS connector.

When the triggering device is pressed the contactor is closed and the welding terminals are “Hot.”

When the triggering device is released the contactor is opened and the welding terminals are “Cold.”

12. **LOCAL/REMOTE SWITCH:** The toggle switch on the control panel labeled “LOCAL/REMOTE” gives you the option of controlling the output at the welder control panel or at a remote location.

For remote control, set the toggle switch in the “REMOTE” position.

For control at the welder control panel, set the toggle switch in the “LOCAL” position.

13. **6 - PIN CONNECTOR:** The 6-pin connector located on the control panel allows for connection of Remote Control accessories.

14. **WELD OUTPUT TERMINALS + AND - :** These 1/2 - 13 studs with flange nuts provide welding connection points for the electrode and work cables. For positive polarity welding, the electrode cable connects to the “+” terminal and the work cable connects to the “-” terminal. For negative polarity welding, the work cable connects to the “+” terminal and the electrode cable connects to the “-” terminal.

# OPERATION

## AUXILIARY POWER CONTROLS

(Figure B.1 Items 15 - 19)

15. **120/240VAC RECEPTACLE:** This is a 120/240VAC (14-50R) receptacle that provides 240VAC or can be split for 120VAC single phase auxiliary power. The receptacle has a 50 amp rating. Refer to **"Auxiliary Power Receptacles"** in the **Installation** section for further information about this receptacle. Also refer to **"Auxiliary Power Operation"** later in this section.
16. **50 AMP CIRCUIT BREAKERS:** These circuit breaker provide separate overload current protection for each 120V circuit at the 240V receptacle.
17. **120VAC RECEPTACLES:** These two 120VAC (5-15R) receptacles with GFCI protection provide 120VAC for auxiliary power. The receptacles have a 20 amp total rating. Refer to **"Auxiliary Power Receptacles"** in the **Installation** section for further information about these receptacles. Also refer to **"Auxiliary Power Operation"** later in this section.
18. **15 AMP CIRCUIT BREAKERS:** These circuit breakers provide separate overload current protection for each 120V receptacle.
19. **GROUND STUD:** Provides a point for connecting the machine case to earth ground for the safest grounding procedure. Refer to **"Machine Grounding"** in the **Installation** section for proper machine grounding information.

## WIRE FEEDER MODE CONTROLS

(Figure B.1 Items 20 - 24 Stick & Wire model only)

20. **WELD OUTPUT TERMINAL - WIRE:** This 1/2-13 stud with flange nut provides a welding connection point for the electrode or work cables. For positive polarity welding, the electrode cable connects to the "+" terminal and the work cable connects to the "-" terminal. For negative polarity welding, the work cable connects to the "+" terminal and the electrode cable connects to the "-" terminal.
21. **15 AMP CIRCUIT BREAKER:** This circuit breaker provides overload protection for the 14-pin connector.
22. **VOLTMETER +/- SWITCH:** Changes the polarity display on the wire feeder.
23. **VOLTS-AMPS SWITCH:** Switches the display between volts and amps.
24. **14 - PIN CONNECTOR:** For quick connection of wire feeder control cable.

## ENGINE OPERATION

### STARTING THE ENGINE

1. Open the engine compartment door and check that the fuel shutoff valve located to the left of the fuel filter housing is in the open position (lever in line with the hose).
2. Check for proper oil level on the oil dipstick. Close engine compartment door.
3. Remove all plugs connected to the AC power receptacles.
4. Set the IDLER switch to "AUTO."
5. Set the RUN/STOP switch to "RUN." Observe that all engine protection lights momentarily turn on. Some lights may turn off before starting. Check the fuel gauge to make sure that there is an adequate fuel level.
6. Press and hold the engine START button for a minimum of 2 seconds.
7. Release the engine START button when the engine starts.
8. Check that the indicator lights are off. If the LOW FUEL light is on, the engine will shut down 30 minutes after starting. If any other indicator light is on after starting, the engine will shut down in a few seconds. Investigate any indicated problem.
9. Allow the engine to warm up at low idle speed for several minutes before applying a load and/or switching to high idle. Allow a longer warm up time in cold weather.

### COLD WEATHER STARTING

With a fully charged battery and the proper weight oil, the engine should start satisfactorily even down to about 0°F.

If the engine must be frequently started below 10°F, it may be desirable to install the optional Ether Start kit (K825-1). Installation and operating instructions are included in the kit. Use ether starting only when required, because excessive use shortens engine life.

OPERATION

STOPPING THE ENGINE

- 1. Switch the RUN/STOP switch to “STOP.” This turns off the voltage supplied to the shut down solenoid. A backup shut down can be accomplished by shutting off the fuel valve located on the fuel filter housing.

BREAK-IN PERIOD

The engine used to supply power for your welder is a heavy duty, industrial engine. It is designed and built for rugged use. It is very normal for any engine to use small quantities of oil until the break-in is accomplished. Check the oil level twice a day during the break-in period (about 200 running hours).

⚠ CAUTION

During break-in, subject the Commander 400 to heavy loads. Avoid long periods running at idle. Before stopping the engine, remove all loads and allow the engine to cool several minutes.

The heavy loading of the engine during break-in, within the rating of the machine, is recommended to properly seat the piston rings and prevent wetstacking. Wetstacking is an accumulation of unburned fuel and/or lubricant in the form of a wet, black, tar-like substance in the exhaust pipe. The rings are seated and the break-in period is complete when there are no longer any signs of wetstacking, which should occur within the first 50 to 100 hours of operation.

⚠ CAUTION

Using your welder at low amperages with long idle running periods during the break-in period may result in a glaze forming on the engine cylinder walls and the rings not seating properly. No amount of loading will properly seat the piston rings after they are glazed over.

TYPICAL FUEL CONSUMPTION

Refer to Table B.2 for typical fuel consumption of the Commander 400 engine for various operating scenarios.

Table B.2 Deutz F3L 912 Engine Fuel Consumption

	Deutz F3L 912 44.2 Hp @ 1800 RPM	Running Time for 25 gallons (Hours)
Low Idle - No Load 1350 RPM	.30 gallons/hour (1.36 liters/hour)	83.3
High Idle - No Load 1900 RPM	.78 gallons/hour ( 3.55 liters/hour)	32.1
DC CC Weld Output 400 Amps @ 40 Volts	1.84 gallons/hour ( 8.36 liters/hour)	13.6
Auxiliary Power 10,000 VA	1.32 gallons/hour (6.00 liters/hour)	18.9

# OPERATION

## WELDER OPERATION

### STICK WELDING

The Commander 400 can be used with a broad range of DC stick electrodes.

The OUTPUT RANGE switch provides six overlapping slope controlled current ranges. The OUTPUT CONTROL adjusts the current from minimum to maximum within each range. Open circuit voltage is also controlled by the OUTPUT CONTROL in the slope controlled setting. These slope controlled settings are intended for “out-of-position” welding, including pipe welding, where the operator would like to control the current level by changing the arc length.

### PIPE WELDING

When using a sloped range, a high open circuit voltage setting provides the softest arc with best resistance to pop-outs. To get this characteristic, set the OUTPUT RANGE switch to the lowest setting that still provides the current you need and set the OUTPUT CONTROL near maximum. For example: to obtain 175 amps and a soft arc, set the OUTPUT RANGE switch to the “180 MAX” position and then adjust the OUTPUT CONTROL for 175 amps.

When a forceful “digging” arc is required, use a higher setting and lower open circuit voltage. For example: to obtain 175 amps and a forceful arc, set the OUTPUT RANGE switch to the “230 MAX” position and then adjust the OUTPUT CONTROL to get 175 amps.

### GENERAL WELDING

The seventh position of the OUTPUT RANGE switch is designed for horizontal welds with all types of electrodes, especially low hydrogen. The OUTPUT CONTROL adjusts the full range of 50 to 575 amps. This setting provides a soft, constant current arc. If a more forceful arc is desired, then select the proper range from the slope controlled current ranges.

### TIG WELDING

The Commander 400 can be used in a wide variety of DC Tungsten Inert Gas (TIG) welding applications for DC TIG welding up to 400 amps at a 20% duty cycle, 300 amps at a 60% duty cycle and 250 amps at a 80% duty cycle. Refer to **Table B.3** for recommended output setting depending on the tungsten electrode size. The Commander 400 can be used without a TIG module or Hi-Freq Unit for scratch start DC TIG welding. Using a K799 Hi-Freq Unit or K930-1 TIG Module enables DC TIG welding without having to scratch start. The end of this section also details Commander 400 settings when using either of these units for DC TIG welding. See **“Commander 400 Settings When Using the K799 Hi-Freq Unit”** and **“Commander 400 Settings When Using the K930-1 TIG Module.”** See the **Accessories** section for recommended equipment for TIG welding.

COMMANDER 400



# OPERATION

**Table B.3 TYPICAL CURRENT RANGES<sup>1</sup> FOR TUNGSTEN ELECTRODES<sup>2</sup>**

Tungsten Electrode Diameter in. (mm)	DCEN (-)	DCEP (+)	Approximate Argon Gas Flow Rate C.F.H. (l/min.)		TIG TORCH Nozzle Size <sup>4,5</sup>
	1%, 2% Thoriated Tungsten	1%, 2% Thoriated Tungsten	Aluminum	Stainless Steel	
0.010 (.25)	2-15	<sup>3</sup>	3-8 (2-4)	3-8 (2-4)	#4, #5, #6
0.020 (.50)	5-20	<sup>3</sup>	5-10 (3-5)	5-10 (3-5)	
0.040 (1.0)	15-80	<sup>3</sup>	5-10 (3-5)	5-10 (3-5)	
1/16 (1.6)	70-150	10-20	5-10 (3-5)	9-13 (4-6)	#5, #6
3/32 (2.4)	150-250	15-30	13-17 (6-8)	11-15 (5-7)	#6, #7, #8
1/8 (3.2)	250-400	25-40	15-23 (7-11)	11-15 (5-7)	
5/32 (4.0)	400-500	40-55	21-25 (10-12)	13-17 (6-8)	#8, #10
3/16 (4.8)	500-750	55-80	23-27 (11-13)	18-22 (8-10)	
1/4 (6.4)	750-1000	80-125	28-32 (13-15)	23-27 (11-13)	

<sup>1</sup> When used with argon gas. The current ranges shown must be reduced when using argon/helium or pure helium shielding gases.

<sup>2</sup> Tungsten electrodes are classified as follows by the American Welding Society (AWS):

Pure	EWP
1% Thoriated	EWTh-1
2% Thoriated	EWTh-2

Though not yet recognized by the AWS, Ceriated Tungsten is now widely accepted as a substitute for 2% Thoriated Tungsten in AC and DC applications.

<sup>3</sup> DCEP is not commonly used in these sizes.

<sup>4</sup> TIG torch nozzle "sizes" are in multiples of 1/16ths of an inch:

# 4 = 1/4 in.	(6 mm)
# 5 = 5/16 in.	(8 mm)
# 6 = 3/8 in.	(10 mm)
# 7 = 7/16 in.	(11 mm)
# 8 = 1/2 in.	(12.5 mm)
#10 = 5/8 in.	(16 mm)

<sup>5</sup> TIG torch nozzles are typically made from alumina ceramic. Special applications may require lava nozzles, which are less prone to breakage, but cannot withstand high temperatures and high duty cycles.

## COMMANDER 400 SETTINGS WHEN USING THE K799 HI-FREQ UNIT

1. Set the OUTPUT RANGE switch to the 50-575 setting (Fabrication and General Purpose).
2. Set the IDLER switch to the "HIGH" position.
3. Set the LOCAL/REMOTE switch to the "REMOTE" position.
4. Set the WELDING TERMINALS switch to the "WELDING TERMINALS ALWAYS ON" position. This will close the solid state contactor and provide an always "hot" electrode.

(Note: This is necessary because the K799 circuitry with respect to the #2 and #4 leads does not provide the proper signal to open and close the solid state contactor in the Commander).

## COMMANDER 400 SETTINGS WHEN USING THE K930-1 TIG MODULE

1. Set the OUTPUT RANGE switch to the 50-575 Setting (Fabrication and General Purpose).
2. Set the IDLER switch to the "AUTO" position.
3. Set the LOCAL/REMOTE switch to the "REMOTE" position.
4. Set the WELDING TERMINALS switch to the "WELDING TERMINALS REMOTELY CONTROLLED" position. This will keep the solid state contactor open and provide a "cold" electrode until the triggering device (Amptrol or Arc Start switch) is pressed.

## COMMANDER 400





OPERATION

WIRE FEED (CONSTANT VOLTAGE) WELDING

Stick and Wire models only. Connect a wire feeder to the Commander 400 (see the **Accessories** section) and set the welder controls according to the instructions in “Controls and Settings” in this section of the manual.

The Stick and Wire model of the Commander 400, with its CV tap, permits it to be used with a broad range of flux cored wire (inner shield and Outer shield) electrodes and solid wires for MIG (GMAW).

For any electrodes, the procedures should be kept within the rating of this machine. For additional electrode information, see Lincoln publications N-675, GS-100 and GS-210.

AUXILIARY POWER

⚠ WARNING

Be sure that any electrical equipment plugged into the generator AC power receptacles can withstand a  $\pm 10\%$  voltage and a  $\pm 3\%$  frequency variation.

The Commander 400 can produce 10,000 watts of 60 Hz, single-phase auxiliary power. (The rating in watts is equivalent to volt-amperes at unity power factor.) The output voltage is within  $\pm 10\%$  at all loads up to the rated capacity.

The following receptacles are provided:

- Two 15 amp-120VAC duplex GFCI receptacles (5-15R)
- One 50 amp-120/240VAC receptacle (14-50R)

The 50 amp receptacle has a maximum permissible output of 44 amps. However, it can be split to power two separate, single-phase 120VAC branch circuits each capable of 44 amps output.

**NOTE:** The two 120VAC outlets of the 120/240VAC receptacle cannot be paralleled. They are on two different phases.

The auxiliary power receptacles should be used with only three-wire, grounded type plugs or approved double-insulated tools with two-wire plugs. The current rating of any plug used with the system must be at least equal to the current-carrying capacity of the associated receptacle. An optional power plug kit is available. See the **Accessories** section.

SIMULTANEOUS WELDING AND AUXILIARY POWER LOADS

The auxiliary power ratings above are with no welding load. Simultaneous welding and power loads are specified in Table B.4. The permissible currents shown assume that current is being drawn from either the 120 VAC or 240 VAC supply (not both at the same time).

TABLE B.4 Commander 400 Simultaneous Welding and Power Loads

Welding Output Range Setting	Welding Output	Permissible Power - Watts (Unity Power Factor)	Permissible Auxiliary Current in Amperes	
			@ 120 V $\pm 10\%$ *	@ 240 V $\pm 10\%$
50-575	500A/40V	None	0	0
400	400A/36V	None	0	0
270	270A/31V	3000	28	14
230	230A/29V	6000	56**	28
180	180A/27V	7500	70**	35
120	120A/25V	9500	88**	44
90	90A/24V	9500	88**	44

\* Each GFCI duplex receptacle is limited to 15 amps.

\*\* Not to exceed 44 A per 120 VAC branch circuit when splitting the 240 VAC output.



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# ACCESSORIES

## OPTIONS/ACCESSORIES

The following options/accessories are available for your Commander 400 from your local Lincoln Distributor.

**K802R Power Plug Kit** - Provides a plug for each receptacle. The kit includes 4-120V plugs rated at 15 Amps each and 1-120V/240V Full-KVA plug rated at 50 Amps.

**K857 28 ft. (8.5 m) or K857-1 100 ft. (30.4 m) Remote Control** - Portable control provides same dial range as the output control on the welder from a location up to the specified length from the welder. Has convenient plug for easy connection to the welder. The Commander 400 is equipped with a 6 pin connector for connecting the remote control and a toggle switch for selecting "LOCAL" output control or "REMOTE" output control.

**K704 Accessory Kit** - Includes 35 feet (10 m) of electrode cable and 30 feet (9 m) of work cable, head shield, work clamp and electrode holder. Cable is rated at 500 amps, 60% duty cycle.

**K953-1 Two Wheel Trailer** - For road, in-plant and yard towing. Road towing with optional fender & light kit. (For highway use, consult applicable federal, state and local laws regarding possible additional requirements.)

- K953-1 Trailer
- K958-1 Ball Hitch
- K958-2 Lunette Eye Hitch
- K959-1 Fender & Light Kit
- K965-1 Cable Storage Rack

**K825-1 Ether Start Kit** - Provides maximum cold weather starting assistance for frequent starting below 10°F (-12.2°C). Required Ether tank is not provided with kit.

**K899-1 Spark Arrestor Kit** - Easily mounts to standard muffler.

**K949-1 Oil Drain Kit** - Includes ball valve, hose and clamp.

## STICK WELDING

K704 Accessory Kit which includes:

- Electrode holder and cable.
- Ground clamp and cable.
- Head shield.

## TIG WELDING

Magnum TIG Torch  
Magnum Parts Kit and Argon gas  
K930-1 TIG Module (not required for scratch start DC TIG welding)

K936-3 Control Cable  
K870 Foot Amptrol

Also available:

K963 Hand Amptrol  
K814 Arc Start Switch  
K937-22 Control Cable Extension  
K937-45 Control Cable Extension  
K844-1 Water Valve

## HIGH FREQUENCY GENERATORS FOR TIG APPLICATIONS

The K799 Hi-Freq Unit and the K930-1 TIG Module are suitable for use with the Commander 400. The Commander is equipped with the required R.F. bypass circuitry for the connection of high frequency generating equipment. The high frequency bypass network supplied with the K799 Hi-Freq Unit **does NOT** need to be installed into the Commander 400.

The Commander 400 and any high frequency generating equipment must be properly grounded. See the K799 Hi-Freq Unit and the K930-1 TIG Module operating manuals for complete instructions on installation, operation, and maintenance.

## SEMI-AUTOMATIC WELDING ACCESSORIES

**LN-25 Wire Feeder** - This portable wire feeder is capable of CC/CV wire feed welding.

**LN-7 or LN-8 Wire Feeders** - Semiautomatic, constant speed wire feeder. For CV operation only.

**LN-23P Wire Feeder** - This portable wire feeder is capable of CV operation. K350-1 adapter kit is required.

**NOTE:** Gas-shielded welding requires a Magnum Gun. Gasless welding requires an Inner shield Gun.

**Magnum Spool Gun (K487-25)** - A lightweight, semi-automatic wire feeder for aluminum welding with argon gas. Has built-in remote wire speed control in the handle. Requires the K488 SG Control Module with appropriate control cable. Includes 25 feet (7.6 meters) of power cable.

COMMANDER 400



## CONNECTION OF LINCOLN ELECTRIC WIRE FEEDERS

### ⚠ WARNING

**ELECTRIC SHOCK can kill.**



- Do not operate with panels open.
- Disconnect NEGATIVE (-) BATTERY LEAD before servicing.
- Do not touch electrically live parts.

**MOVING PARTS can injure.**



- Keep guards in place.
- Keep away from moving parts.
- Only qualified personnel should install, use or service this equipment.

### CONNECTION OF THE LN-7 TO THE COMMANDER 400 USING K867 UNIVERSAL ADAPTER (SEE FIGURE C.1.)

1. Shut the welder off.
2. Connect the electrode cable from the LN-7 to the "+" terminal of the welder. Connect the work cable to the "CV- Wire" terminal of the welder.

**NOTE:** Welding cable must be sized for current and duty cycle of application.

**NOTE:** Figure C.1 shows the electrode connected for positive polarity. To change polarity, shut the welder off and reverse the electrode and work cables at the Commander 400 output terminals.

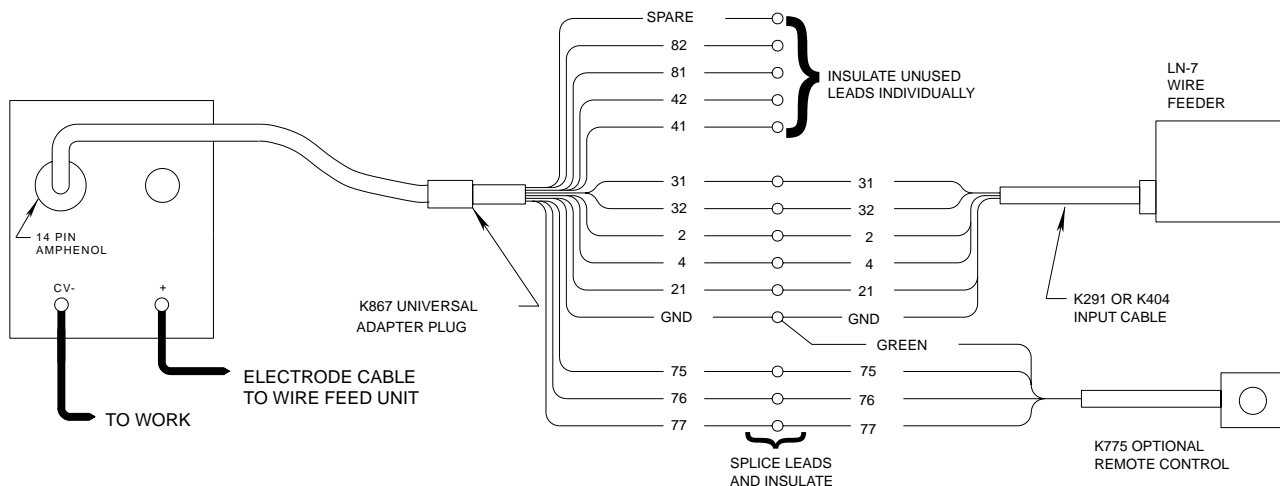
3. Connect the K867 Universal Adapter to the K291 or K404 input cable and the 14 pin amphenol of the Commander 400 as indicated in Figure C.1. Make the proper connections for local or remote control according to Figure C.1.

4. Connect the K291 or K404 input cable to the LN-7.
5. Place the IDLER switch in the "HIGH" position.

Any increase of the high idle engine RPM by changing the governor setting or overriding the throttle linkage will cause an increase in the AC auxiliary voltage. If this voltage goes over 140 volts, wire feeder control circuits may be damaged. The engine governor setting is preset at the factory — do not adjust above RPM specifications listed in this manual.

6. Set the LOCAL/REMOTE switch to "REMOTE" if a K775 remote control is used. Set the switch to "LOCAL" if no remote control is used.
7. Set the VOLTMETER switch to "+" or "-" depending on the polarity chosen.
8. Set the RANGE switch to "WIRE WELDING CV."
9. Set the WELDING TERMINALS switch to "WELDING TERMINAL REMOTELY CONTROLLED."
10. Adjust wire feed speed at the LN-7.

**FIGURE C.1  
COMMANDER 400/LN-7 WITH K867 ADAPTER CONNECTION DIAGRAM**



**COMMANDER 400**



## CONNECTION OF THE LN-7 TO THE COMMANDER 400 USING K584 INPUT CABLE ASSEMBLY (SEE FIGURE C.2.)

1. Shut the welder off.
2. Connect the electrode cable from the LN-7 to the "+" terminal of the welder. Connect the work cable to the "CV- Wire" terminal of the welder.

**NOTE:** Welding cable must be sized for current and duty cycle of application.

**NOTE:** Figure C.2 shows the electrode connected for positive polarity. To change polarity, shut the welder off and reverse the electrode and work cables at the Commander 400 output terminals.

3. Connect the K584-XX Input Cable Assembly to the LN-7.
4. Connect the K584-XX input cable assembly to the 14 pin amphenol on the Commander 400.
5. Place the IDLER switch in the "HIGH" position.

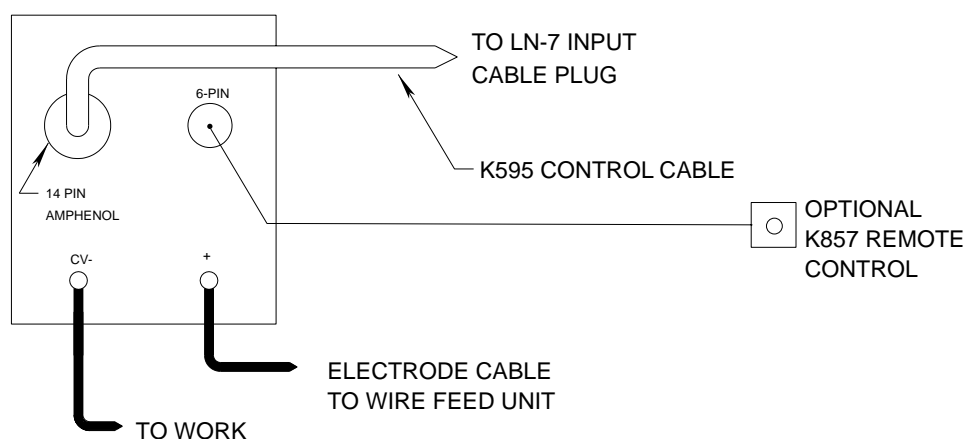
### ⚠ CAUTION

Any increase of the high idle engine RPM by changing the governor setting or overriding the throttle linkage will cause an increase in the AC auxiliary voltage. If this voltage goes over 140 volts, wire feeder control circuits may be damaged. The engine governor setting is preset at the factory — do not adjust above RPM specifications listed in this manual.

6. Set the LOCAL/REMOTE switch to "REMOTE" if a K857 remote control is used. Set the switch to "LOCAL" if no remote control is used.
7. Set the VOLTMETER switch to "+" or "-" depending on the polarity chosen.
8. Set the RANGE switch to "WIRE WELDING CV."
9. Set the WELDING TERMINALS switch to "WELDING TERMINALS REMOTELY CONTROLLED."
10. Adjust wire feed speed at the LN-7.

**NOTE:** For remote control, a K857 control is required. Connect it to the 6 pin amphenol.

**FIGURE C.2  
COMMANDER 400/LN-7 WITH K584 INPUT CABLE ASSEMBLY CONNECTION DIAGRAM**



**COMMANDER 400**



## CONNECTION OF THE LN-8 TO THE COMMANDER 400 USING K867 UNIVERSAL ADAPTER (SEE FIGURE C.3.)

1. Shut the welder off.
2. Connect the electrode cable from the LN-8 to the "+" terminal of the welder. Connect the work cable to the "CV- Wire" terminal of the welder.

**NOTE:** Welding cable must be sized for current and duty cycle of application.

**NOTE:** Figure C.3 shows the electrode connected for positive polarity. To change polarity, shut the welder off and reverse the electrode and work cables at the Commander 400 output terminals.

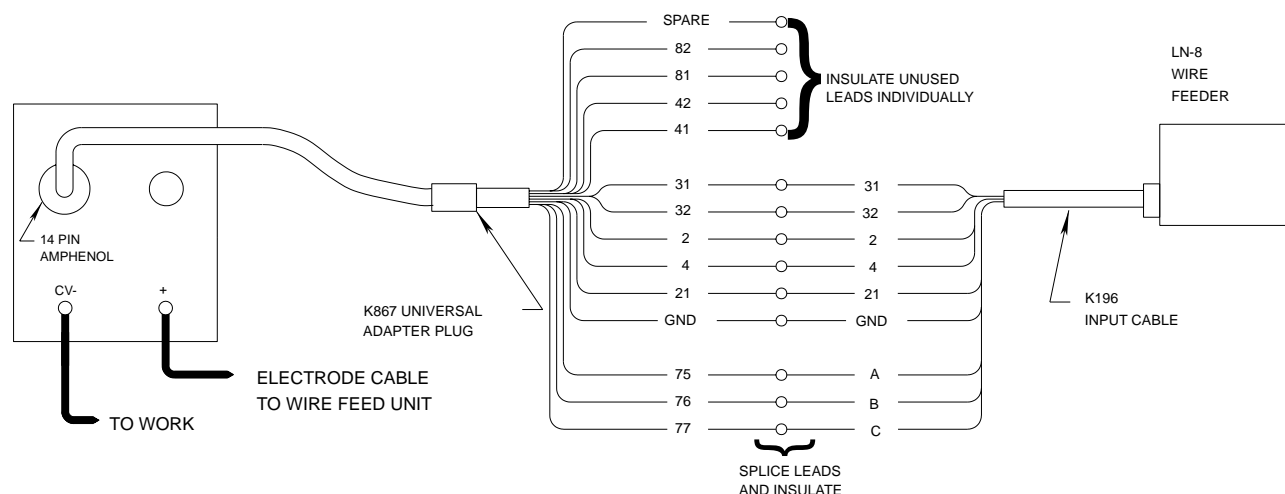
3. Connect the K867 Universal Adapter to the K196 input cable and the 14 pin amphenol of the Commander 400 as indicated in Figure C.3. Make the proper connections for local or remote control according to Figure C.3.
4. Connect the K196 input cable to the LN-8.
5. Place the IDLER switch in the "HIGH" position.

### ⚠ CAUTION

Any increase of the high idle engine RPM by changing the governor setting or overriding the throttle linkage will cause an increase in the AC auxiliary voltage. If this voltage goes over 140 volts, wire feeder control circuits may be damaged. The engine governor setting is preset at the factory — do not adjust above RPM specifications listed in this manual.

6. Set the LOCAL/REMOTE switch to "REMOTE."
7. Set the VOLTMETER switch to "+" or "-" depending on the polarity chosen.
8. Set the RANGE switch to "WIRE WELDING CV."
9. Set the WELDING TERMINALS switch to "WELDING TERMINALS REMOTELY CONTROLLED."
10. Adjust wire feed speed and voltage at the LN-8.

**FIGURE C.3  
COMMANDER 400/LN-8 WITH K867 ADAPTER CONNECTION DIAGRAM**



COMMANDER 400



## CONNECTION OF THE LN-8 TO THE COMMANDER 400 USING K595 INPUT CABLE ASSEMBLY (SEE FIGURE C.4.)

1. Shut the welder off.
2. Connect the electrode cable from the LN-8 to the "+" terminal of the welder. Connect the work cable to the "CV- Wire" terminal of the welder.

**NOTE:** Welding cable must be sized for current and duty cycle of application.

**NOTE:** Figure C.4 shows the electrode connected for positive polarity. To change polarity, shut the welder off and reverse the electrode and work cables at the Commander 400 output terminals.

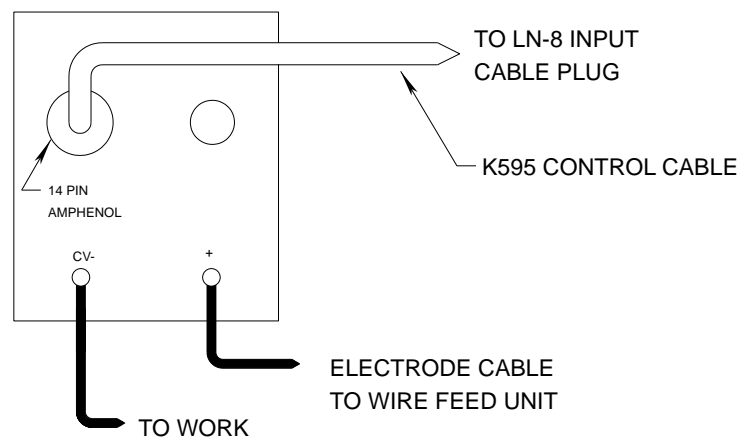
3. Connect the K595-XX Input Cable Assembly to the LN-8.
4. Connect the K595-XX to the 14 pin amphenol on the Commander 400.
5. Place the IDLER switch in the "HIGH" position.

### ⚠ CAUTION

Any increase of the high idle engine RPM by changing the governor setting or overriding the throttle linkage will cause an increase in the AC auxiliary voltage. If this voltage goes over 140 volts, wire feeder control circuits may be damaged. The engine governor setting is preset at the factory — do not adjust above RPM specifications listed in this manual.

6. Set the LOCAL/REMOTE switch to "REMOTE."
7. Set the VOLTMETER switch to "+" or "-" depending on the polarity chosen.
8. Set the RANGE switch to "WIRE WELDING CV."
9. Set the WELDING TERMINALS switch to "WELDING TERMINALS REMOTELY CONTROLLED."
10. Adjust wire feed speed and voltage at the LN-8.

**FIGURE C.4**  
**COMMANDER 400/LN-8 WITH K595 INPUT CABLE ASSEMBLY CONNECTION DIAGRAM**



**COMMANDER 400**





# ACCESSORIES

## CONNECTION OF THE LN-23P TO THE COMMANDER 400 USING K350-1 ADAPTER (SEE FIGURE C.5.)

1. Shut the welder off.
2. Connect the electrode cable from the LN-23P to the "CV- Wire" terminal of the welder. Connect the work cable to the "+" terminal of the welder.

**NOTE:** Welding cable must be sized for current and duty cycle of application.

**NOTE:** Figure C.5 shows the electrode connected for negative polarity.

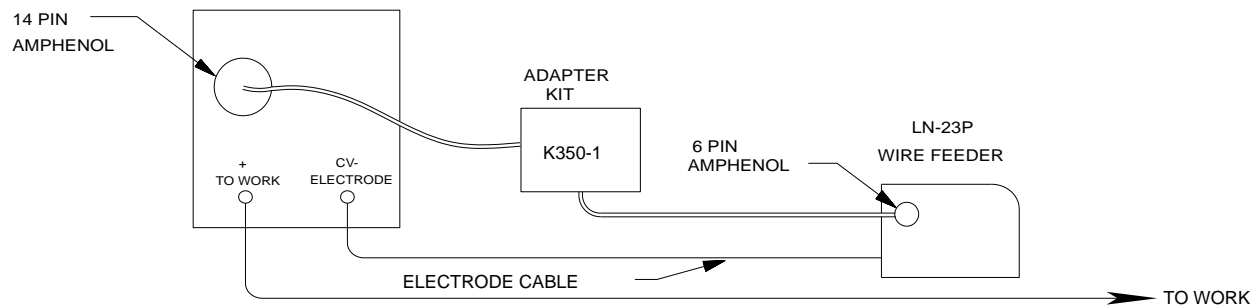
3. Connect the K350-1 adapter to the 6 pin amphenol on the LN-23P and the 14 pin amphenol of the Commander 400 as indicated in Figure C.5.
4. Place the IDLER switch in the "AUTO" position.

## ⚠ CAUTION

Any increase of the high idle engine RPM by changing the governor setting or overriding the throttle linkage will cause an increase in the AC auxiliary voltage. If this voltage goes over 140 volts, wire feeder control circuits may be damaged. The engine governor setting is preset at the factory — do not adjust above RPM specifications listed in this manual.

5. Set the VOLTMETER switch to negative.
6. Set the RANGE switch to "WIRE WELDING CV."
7. Set the WELDING TERMINALS switch to "WELDING TERMINALS REMOTELY CONTROLLED."
8. Set the LOCAL/REMOTE switch according to whether you are controlling the welder at the machine or remotely.
9. Adjust wire feed speed and voltage at the LN-23P.

**FIGURE C.5  
COMMANDER 400/LN-23P CONNECTION DIAGRAM**



**COMMANDER 400**



## CONNECTION OF THE LN-25 TO THE COMMANDER 400 "ACROSS THE ARC" (SEE FIGURE C.6.)

1. Shut the welder off.
2. Connect the electrode cable from the LN-25 to the "-" terminal of the welder. Connect the work cable to the "CV-" terminal of the welder.

**NOTE:** Welding cable must be sized for current and duty cycle of application.

**NOTE:** Figure C.6 shows the electrode connected for negative polarity. To change polarity, shut the welder off and reverse the electrode and work cables at the Commander 400 output terminals. Reverse the LN-25 polarity switch.

3. Attach the single lead from the LN-25 control box to the work using the spring clip on the end of the lead. This is only a control lead — it carries no welding current.
4. Place the IDLER switch in the "AUTO" position.

### ⚠ CAUTION

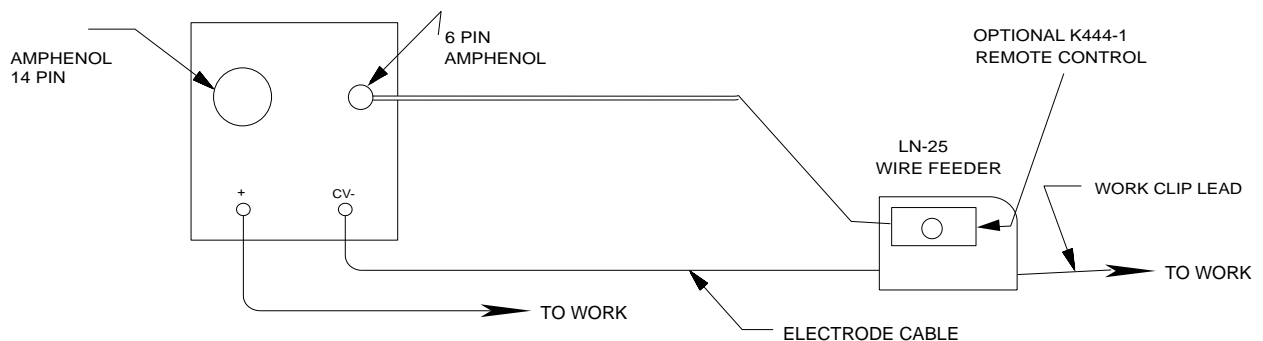
If you are using an LN-25 without an internal contactor, the electrode will be "HOT" when the Commander 400 is started.

5. Set the RANGE switch to "WIRE WELDING CV."
6. Set the WELDING TERMINALS switch to "WELDING TERMINALS ALWAYS ON."
7. Set the VOLT METER switch to "+" or "-" depending on the polarity chosen.
8. Adjust wire feed speed at the LN-25.
9. Set the LOCAL/REMOTE switch to "REMOTE" if a K444-1 remote control is used.

### ⚠ CAUTION

Electrode is always "HOT."

**FIGURE C.6  
COMMANDER 400/LN-25 ACROSS THE ARC CONNECTION DIAGRAM**



**COMMANDER 400**



# ACCESSORIES

## CONNECTION OF THE K488 SG CONTROL MODULE AND K487 MAGNUM SPOOL GUN TO THE COMMANDER 400 (SEE FIGURE C.7.)

1. Shut the welder off.
2. Connect the electrode cable from the SG Control Module to the "+" terminal of the welder. Connect the work cable to the "CV- Wire" terminal of the welder.

**NOTE:** Welding cable must be sized for current and duty cycle of application.

**NOTE:** Figure C.7 shows the electrode connected for positive polarity. To change polarity, shut the welder off and reverse the electrode and work cables at the Commander 400 output terminals.

3. Connect the K691-10 input cable as shown in Figure C.7.
4. Set the slide switch on the SG Control Module to the "Lincoln" position.

### CAUTION

Be sure this switch is set to the "Lincoln" (contact closure) position before attempting to operate the SG Control Module. Incorrect switch position could result in damage to the SG Control Module and/or the Commander 400.

5. Place the IDLER switch on the Commander 400 in the "HIGH" position.

### CAUTION

Any increase of the high idle engine RPM by changing the governor setting or overriding the throttle linkage will cause an increase in the AC auxiliary voltage. If this voltage goes over 140 volts, wire feeder control circuits may be damaged. The engine governor setting is preset at the factory — do not adjust above RPM specifications listed in this manual.

6. Set the LOCAL/REMOTE switch to "REMOTE" if a K857 remote control is used. Set the switch to "LOCAL" if no remote control is used.
7. Set the VOLTMETER switch to "+" or "-" depending on the polarity chosen.
8. Set the RANGE switch to "WIRE WELDING CV."
9. Set the WELDING TERMINALS switch to "WELDING TERMINALS REMOTELY CONTROLLED."
10. Adjust wire feed speed at the SG Control Module.

**NOTE:** For remote control, a K857 remote control is required. Connect it to the 6 pin amphenol.

**FIGURE C.7**  
**COMMANDER 400/K691/K488/K487 SPOOL GUN CONNECTION DIAGRAM**



COMMANDER 400



NOTES

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# MAINTENANCE

## SAFETY PRECAUTIONS

### ⚠ WARNING

- Have qualified personnel do all maintenance and troubleshooting work.
- Turn the engine off before working inside the machine.
- Remove covers or guards only when necessary to perform maintenance and replace them when the maintenance requiring their removal is complete.
- If covers or guards are missing from the machine, get replacements from a Lincoln Distributor.

Read the Safety Precautions in the front of this manual and in the instruction manual for the diesel engine used with your machine before working on the Commander 400.

Keep all equipment safety guards, covers, and devices in position and in good repair. Keep your hands, hair, clothing, and tools away from the fans, and all other moving parts when starting, operating, or repairing this machine.

## ROUTINE AND PERIODIC MAINTENANCE

### ENGINE MAINTENANCE

### ⚠ CAUTION

To prevent the engine from accidentally starting, disconnect the negative battery cable before servicing the engine.

See **Table D.1** for a summary of maintenance intervals for the items listed below. Follow either the hourly or the calendar intervals, whichever come first. More frequent service may be required, depending on your specific application and operating conditions.

**OIL:** Check the oil level after every 8 hours of operation or daily. **BE SURE TO MAINTAIN THE OIL LEVEL.**

Change the oil the first time between 25 and 50 hours of operation. Then, under normal operating conditions, change the oil as specified in Table D.1. If the engine is operated under heavy load or in high ambient temperatures, change the oil more frequently.

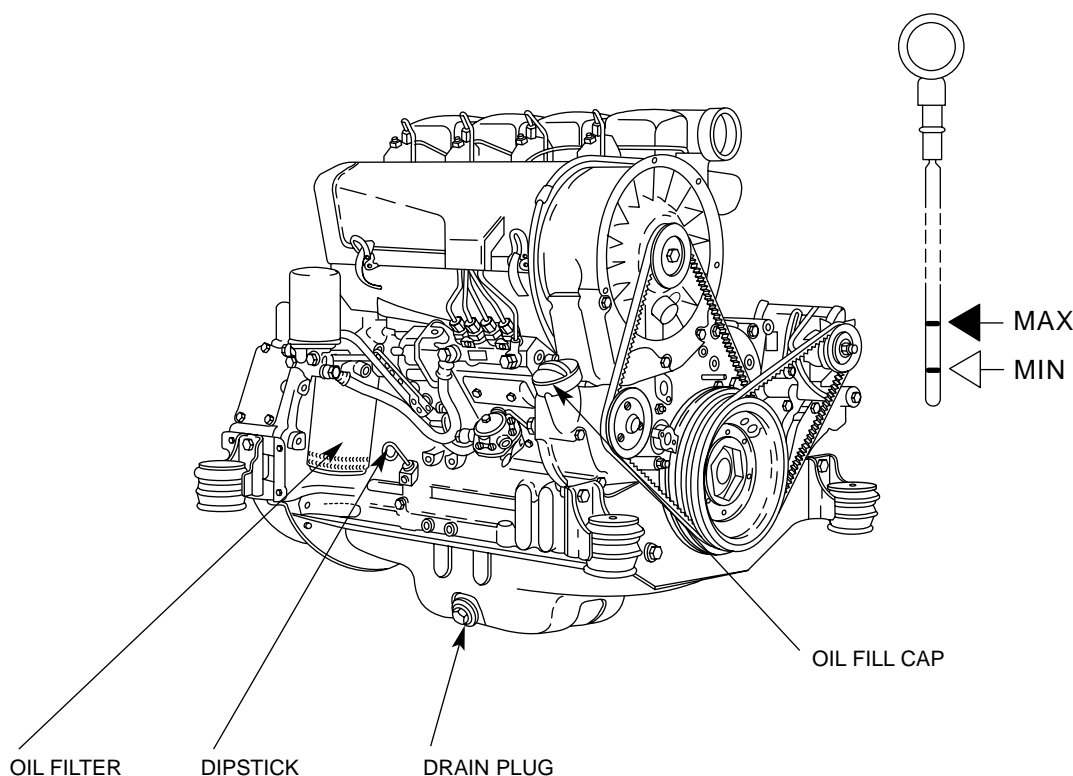
**CHANGE THE OIL:** Change the oil, while the engine is still warm, as follows:

1. Drain the oil from the drain plug located on the engine bottom, as shown in **Figure D.1**. Examine the washer and replace it if it appears damaged.
2. Replace the plug and washer and tighten firmly.
3. Remove the oil fill cap and add oil until the level reaches the "MAX" mark on the dipstick. See **Figure D.1**. Use high quality oil viscosity grade 10W40. Consult the engine manual for oil specifications for various ambient temperatures. Always check the level with the dipstick before adding more oil.
4. Reinstall the oil fill cap and the dipstick.



# MAINTENANCE

## FIGURE D.1 – OIL DRAIN AND REFILL



**CHANGE THE OIL FILTER:** Change the oil filter the first time between 25 and 50 hours of operation. Then, under normal operating conditions, change the oil filter after every 250 hours of operation. If the engine is operated under heavy load or in high ambient temperatures, change the oil filter more frequently. See Table D.1 for recommended maintenance intervals. See Table D.2 for replacement oil filters.

Change the oil filter as follows:

1. Remove the oil drain plug. Drain the oil from the engine and allow the oil filter to drain. See Figure D.1.
2. Remove the old filter (spin it off) and discard it (2). Wipe off the filter mounting surface and adapter. See Figure D.1.
3. Fill the new filter with fresh engine oil. Apply a thin coat of new oil to the rubber gasket on the new oil filter.
4. Spin the new filter onto the mounting adapter finger tight until the gasket is evenly seated. Then turn it down another 1/2 turn. Do not over tighten the new filter.

5. Refill the engine with the proper amount and type of oil as described in the **Change the Oil** section, above. Start the engine and check for leaks around the filter element. Correct any leaks (usually by retightening the filter, but only enough to stop leaks) before placing the Commander 400 back in service.
6. If there are no leaks, stop the engine and recheck the oil level. If necessary, add oil to bring the level up to the "MAX" mark, but do not overfill. See Figure D.1.

**FUEL:** At the end of each day's use, refill the fuel tank to minimize moisture condensation and dirt contamination in the fuel line. Do not overfill; leave room for the fuel to expand.

Refer to your engine operation manual for recommended grade of fuel.

COMMANDER 400



## FUEL FILTERS:

**⚠ WARNING**

When working on the fuel system:



- Keep unshielded lights away, do not smoke !
- Do not spill fuel !

The Commander 400 is equipped with a **Fuel Pre-Filter/Water Separator Assembly** located before the lift pump and a **Secondary Fuel Filter** located after the lift pump and before the fuel injectors. The Fuel Pre-Filter/Water Separator is mounted to the engine block just below the lift pump (Figure D.2). The Secondary Fuel Filter is mounted directly to the engine just above the oil filter (**Figure D.3**).

**Fuel Pre-Filter/Water Separator Assembly:** The pre-filter is a 150 micron screen designed to protect against gross fuel contamination of the water separator element and the Secondary Fuel Filter. If the pre-filter becomes plugged, it may be removed, inspected, cleaned and reinstalled. In general this only needs to be done with each water separator element change (about every 1,000 hrs). However, if at any time excessive fuel contamination is suspected or a sudden fall-off in engine performance is detected the pre-filter screen should be inspected and cleaned. See Figure D.2 and follow this procedure:

1. Close the fuel shutoff valve located on the side of the Fuel Pre-Filter/Water Separator Assembly. The lever should be perpendicular to the hose
2. Unscrew the cap ring located on the top of the filter header and remove the plastic center cap and O-ring.
3. Remove the large white volume plug located directly under the center cap in the upper cavity of the filter header. Use a small screwdriver (or similar device) to lift the plug part way out of the cavity to assist with its removal.

**NOTE:** Be careful not to damage the pre-filter screen with the tool used to remove the plug.

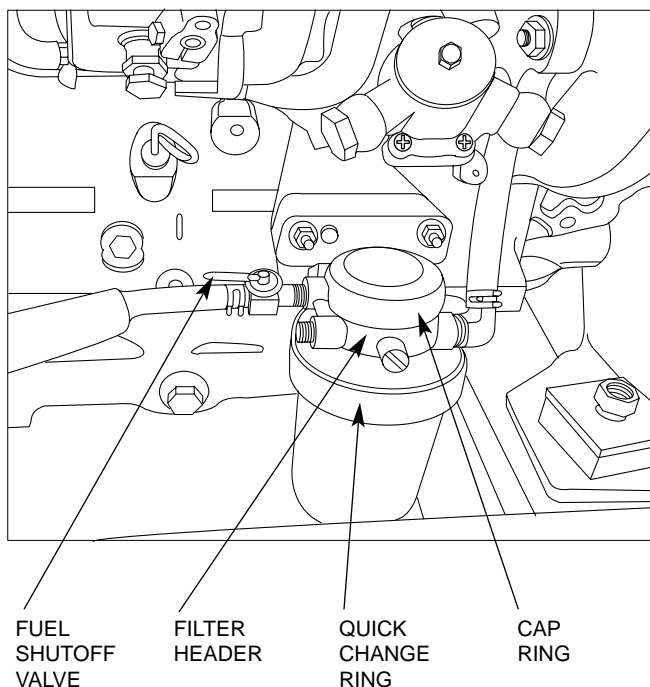
4. Using a pair of pliers, gently tug on the pull tabs of the pre-filter screen in an alternating pattern to gradually remove the pre-filter screen.
5. Brush off any debris and rinse in diesel fuel.
6. Re-install the pre-filter screen into the upper cavity of the filter header making sure the four pull tabs are pointing up. Putting your fingers on the pull tabs, push down evenly until the lower body of the pre-filter screen contacts the floor of the upper cavity.

7. Re-insert the large white volume plug into the upper cavity.
8. Place the O-ring onto the angled seal surface of the filter header and re-install the plastic cap. Make sure its flange rests on the O-ring.
9. Screw on the cap ring and tighten hand tight.
10. Remember to open the fuel shutoff valve (Lever in line with the hose) before starting the engine.

**Water Separator Element:** The water separator element is a two-stage filter with a special filtration/water separating media. An expanded water reservoir provides maximum protection against water in the fuel. The recommended change interval for the water separator element is 1,000 hours. See Figure D.2 and follow this procedure.

1. Close the fuel shutoff valve located on the side of the Fuel Pre-Filter/Water Separator Assembly. The lever should be perpendicular to the hose.
2. Rotate the quick change ring (located just below filter header) clockwise approximately 1/2 turn and slide it down and off the element.
3. Grasp the element and pull down with a slight rocking motion to remove the element from the grommet post on the bottom of the filter header.

**FIGURE D.2 – FUEL PRE-FILTER/WATER SEPARATOR ASSEMBLY**



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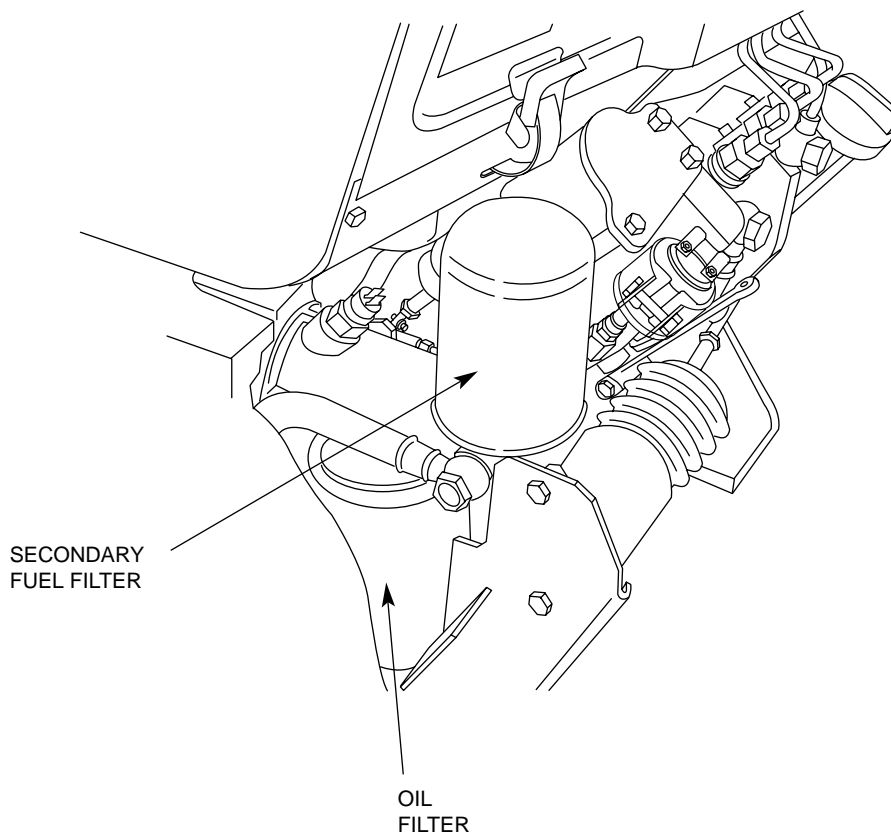
- Slide the new element onto the grommet post on the bottom of the filter header until the element no longer easily moves up into the filter header. Now rotate the element (it may take almost 1 full turn) with a slight upward pressure until the element begins to further engage the header. With the proper orientation now established, apply additional pressure to seat the element in the filter header. You should feel the element "pop" into place when properly seated.

**NOTE:** The element will only go on one way. Never use excessive force when mounting the element to the header.

- Slide the quick change ring up over the element and rotate counter clockwise until an audible click or pop is heard. If you do not hear the click, you have not rotated the ring far enough and the element is not in the locked position. Another indication that the ring is in the locked position is that one set (it doesn't matter which one) of arrows located on the outside of the ring should be located directly under the air vent valve.
- Open the fuel shutoff valve (lever in line with the hose).
- Open the air vent valve on the front of the filter header until fuel emerges free of air bubbles. Then close the air vent valve.

**Secondary Fuel Filter:** The Secondary Fuel Filter is a spin-on cartridge type mounted directly to the engine. Consult your engine operation manual for complete information on service intervals and element changing procedures.

**FIGURE D.3 – SECONDARY FUEL FILTER**



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**BLEEDING THE FUEL SYSTEM:** In the event the engine is operated until it runs out of fuel, you will need to bleed the fuel system in order to start the engine. Refer to the engine operation manual.

**AIR FILTER:**

**⚠ CAUTION**

Excessive air filter restriction will result in reduced engine life.

The air filter element is a dry cartridge type. It can be cleaned and reused. However, damaged elements should not be reused. Stop engine after 100 hours of running time and clean filter element. Replace the filter if necessary. Service the air cleaner regularly according to your engine operation manual.

- 1. Locate the air filter canister located behind the engine door on the top of the engine.
- 2. Remove the air filter element.

- 3. Remove loose dirt from the element with compressed air or a water hose directed from inside out.

Compressed Air: 100 psi maximum with nozzles at least one inch away from the element.

Water Hose: 40 psi maximum without nozzle.

- 4. Soak the element in a mild detergent solution for 15 minutes. Do not soak more than 24 hours. Swish the element around in the solution to help remove dirt.
- 5. Rinse elements from inside out with a gentle stream of water (less than 40 psi) to remove all suds and dirt.
- 6. Dry the element before reuse with warm air at less than 160°F (71°C). Do not use a light bulb to dry the element.
- 7. Inspect for holes and tears by looking through the element toward a bright light. Check for damaged gaskets or dented metal parts. Do not reuse damaged elements. Protect the element from dust and damage during drying and storage.
- 8. Reinstall the air filter element.

After six cleanings, replace the air filter. A cleaned filter will have approximately 70% of the life of a new filter element. A restricted filter element may not appear excessively dirty.



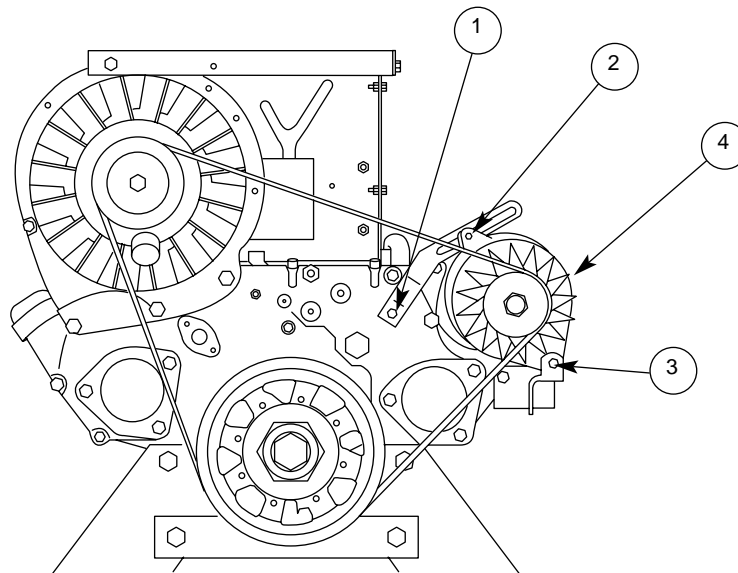
# MAINTENANCE

**COOLING SYSTEM:** The cooling system of the Deutz engine needs to be checked and cleaned periodically. Consult the engine Operation Manual for the proper frequency and procedure.

**COOLING BLOWER BELT:** The following procedure should be followed to replace the cooling blower belt:

1. Allow the machine to cool.
2. Unfasten and slide the battery holder out from the welder.
3. Disconnect the negative battery cable.
4. Remove the engine end panel for access to the engine.
5. See Figure D.4. Loosen the alternator mounting bolts (1, 2, 3) and rotate the alternator toward the engine.
6. Remove the old cooling blower belt and install a new one.
7. Push outward on the alternator (4) and adjust the cold belt tension to 63-73 lbs. (10-15 mm maximum deflection) midway between any two pulleys. Tighten bolts (1), (2), (3).
8. Reinstall the engine end panel. Reattach the negative battery cable. Slide in and refasten the battery holder.
9. Check the cooling blower belt tension after 100 hours of operation.

**FIGURE D.4 – COOLING BLOWER BELT REPLACEMENT AND ADJUSTING**



**COMMANDER 400**



MAINTENANCE

TABLE D.1  
DEUTZ ENGINE MAINTENANCE SCHEDULE

FREQUENCY	MAINTENANCE REQUIRED
Daily or Before Starting Engine	<ul style="list-style-type: none"><li>• Fill fuel tank.</li><li>• Check oil level.</li><li>• Check air cleaner for dirty, loose, or damaged parts. Replace if necessary.</li><li>• Check air intake and cooling areas, clean as necessary.</li></ul>
<sup>1</sup> First 50 Hours and Every 250 Hours Thereafter	<ul style="list-style-type: none"><li>• Change engine oil.</li><li>• Change oil filter.</li><li>• Change fuel filter.</li><li>• Check fan belt.</li></ul>
Every 50 Hours	<ul style="list-style-type: none"><li>• Check fuel lines and clamps.</li></ul>
Every 100 Hours	<ul style="list-style-type: none"><li>• Check battery electrolyte level and connections.</li><li>• Clean air filter.</li></ul>

Refer to your Deutz engine operation manual for periodic maintenance at 100 hours and beyond.

<sup>1</sup>125 Hours for severe conditions.



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# MAINTENANCE

**Table D.2**  
**ENGINE MAINTENANCE PARTS**

ITEM	MANUFACTURER	PART NUMBER
Air Cleaner Element	Donaldson AC	P181052 A302C
Cooling Blower Belt	Lincoln Gates	T13536-3 7585
Oil Filter Element	Deutz Purolator Napa Fram	1174418 PER2168 1820 PH3776
Fuel Filter Element	Deutz Purolator Napa Fram	1174423 PC42 3358 P4102
Water Separator Element	Lincoln Stanadyne	M16890-C 31572
Fuel Pre-Filter Screen	Lincoln Stanadyne	M16890-B 29575
Battery		BCI Group 34

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# MAINTENANCE

## BATTERY MAINTENANCE

### ⚠ WARNING



GASES FROM BATTERY can explode.

- Keep sparks, flame, and cigarettes away from battery.



BATTERY ACID can burn eyes and skin.

- Wear gloves and eye protection and be careful when working near a battery. Follow the instructions printed on the battery.

To prevent EXPLOSION when:

- **INSTALLING A NEW BATTERY** - Disconnect the negative cable from the old battery first and connect to the new battery last.
- **THE CORRECT POLARITY IS NEGATIVE GROUND** - Damage to the engine alternator and the printed circuit board can result from incorrect connection.



- **CONNECTING A BATTERY CHARGER** - Remove the battery from the welder by disconnecting the negative cable first, then the positive cable and battery clamp. When reinstalling, connect the negative cable last. Keep the area well ventilated.

- **USING A BOOSTER** - Connect the positive lead to the battery first, then connect the negative lead to the engine foot.
- To prevent BATTERY BUCKLING, tighten the nuts on the battery clamp until snug.

**CLEANING THE BATTERY:** Keep the battery clean by wiping it with a damp cloth when dirty. If the terminals appear corroded, disconnect the battery cables and wash the terminals with an ammonia solution or a solution of 1/4 pound (0.113 kg) of baking soda and 1 quart (0.946 l) of water. Be sure the battery vent plugs (if equipped) are tight so that none of the solution enters the cells.

After cleaning, flush the outside of the battery, the battery compartment, and surrounding areas with clear water. Coat the battery terminals lightly with petroleum jelly or a non-conductive grease to retard corrosion.

Keep the battery clean and dry. Moisture accumulation on the battery can lead to more rapid discharge and early battery failure.

**CHECKING SPECIFIC GRAVITY:** Check each battery cell with a hydrometer. A fully charged battery will have a specific gravity of 1.260. Charge the battery if the reading is below 1.215.

**NOTE:** Correct the specific gravity reading by adding four gravity points (0.004) for every five degrees the electrolyte temperature is above 80 degrees F (27 degrees C). Subtract four gravity points (.004) for every five degrees the electrolyte temperature is below 80 degrees F (27 degrees C).

**CHECKING ELECTROLYTE LEVEL:** If battery cells are low, fill them to the neck of the filler hole with distilled water and recharge. If one cell is low, check for leaks.

**CHARGING THE BATTERY:** The Commander 400 is equipped with a wet charged battery. The charging current is automatically regulated when the battery is low (after starting the engine) to a trickle current when the battery is fully charged.

When you charge, jump, replace, or otherwise connect battery cables to the battery, be sure the polarity is correct. Improper polarity can damage the charging circuit. **The Commander 400 charging system is NEGATIVE GROUND.** The positive (+) battery terminal has a red terminal cover.

If you need to charge the battery with an external charger, disconnect the negative cable first, then the positive cable before you attach the charger leads. After the battery is charged, reconnect the positive battery cable first and the negative cable last. Failure to do so can result in damage to the internal charger components.

Follow the instructions of the battery charger manufacturer for proper charger settings and charging time.

COMMANDER 400



MAINTENANCE

WELDER/GENERATOR  
MAINTENANCE

**STORAGE:** Store the Commander 400 in clean, dry, protected areas.

**CLEANING:** Blow out the generator and controls periodically with low pressure air. Do this at least once a week in particularly dirty areas.

**NAME PLATES:** Whenever routine maintenance is performed on this machine - or at least yearly - inspect all name plates and labels for legibility. Replace those which are no longer clear. Refer to the parts list for the replacement item number.

**BEARINGS:** The Commander 400 is equipped with double-shielded ball bearings having sufficient grease to last indefinitely under normal service. Where the welder is used constantly or in excessively dirty locations, it may be necessary to add one half ounce of grease per year. A pad of grease one inch wide, one inch long, and one inch high weighs approximately one half ounce. Over-greasing is far worse than insufficient greasing.

When greasing the bearings, keep all dirt out of the area. Wipe the fittings completely clean and use clean equipment. More bearing failures are caused by dirt introduced during greasing than from insufficient grease.

**RECEPTACLES:** Keep the electrical receptacles in good condition. Remove any dirt, oil, or other debris from their surfaces and holes.

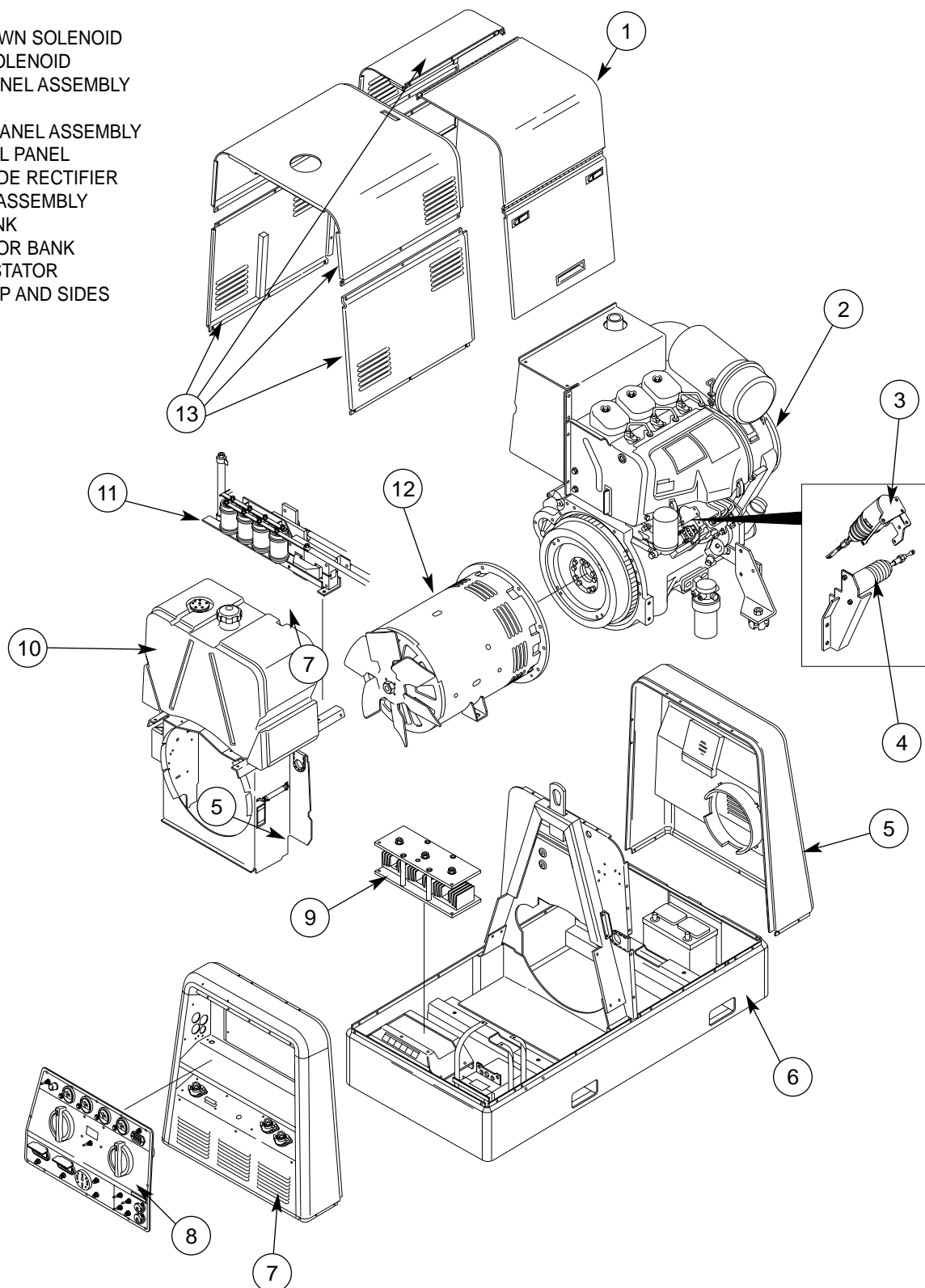
**CABLE CONNECTIONS:** Check the welding cable connections at the weld output terminals often. Be sure that the connections are always tight.



# MAINTENANCE

## FIGURE D.5 - MAJOR COMPONENT LOCATIONS

1. CASE DOOR ASSEMBLY
2. ENGINE
3. SHUTDOWN SOLENOID
4. IDLER SOLENOID
5. REAR PANEL ASSEMBLY
6. BASE
7. FRONT PANEL ASSEMBLY
8. CONTROL PANEL
9. SCR/DIODE RECTIFIER BRIDGE ASSEMBLY
10. FUEL TANK
11. CAPACITOR BANK
12. ROTOR/STATOR
13. CASE TOP AND SIDES



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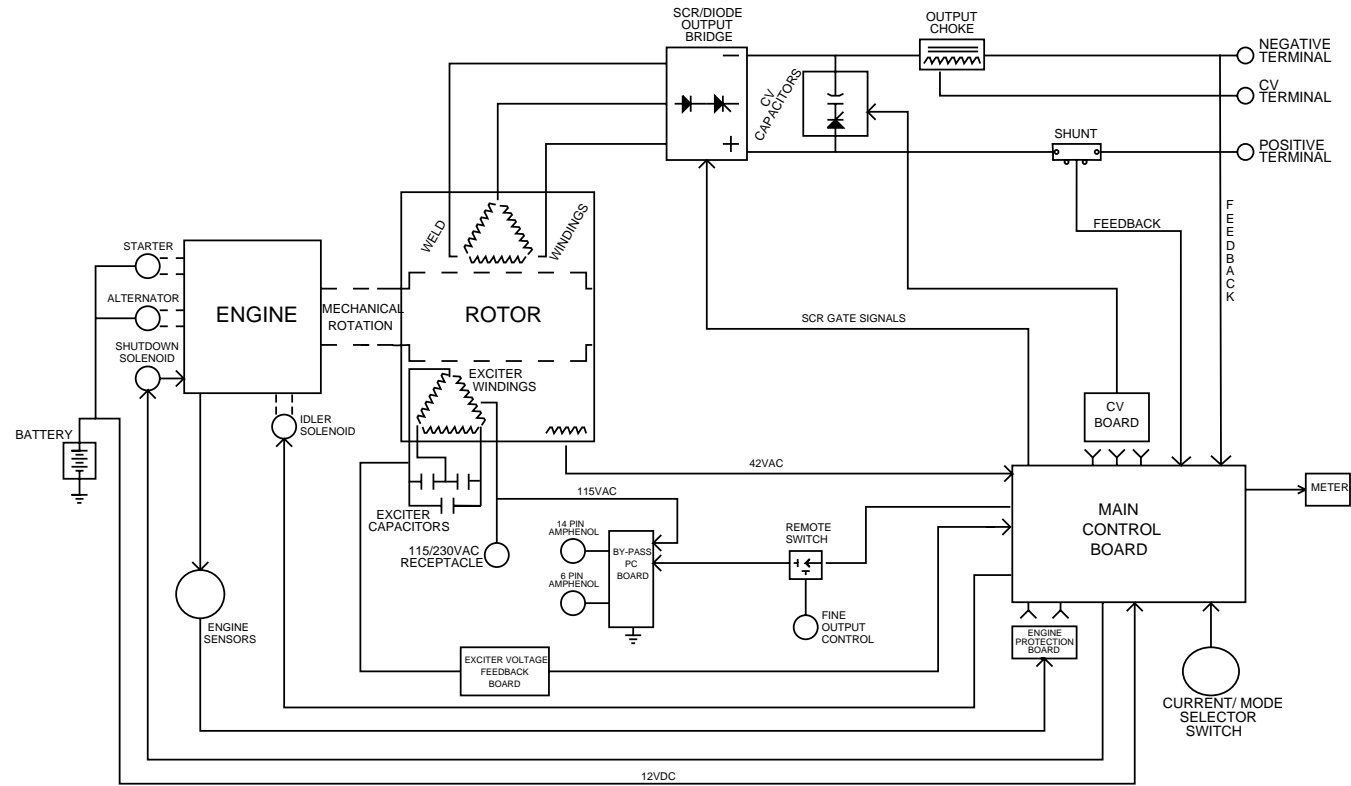
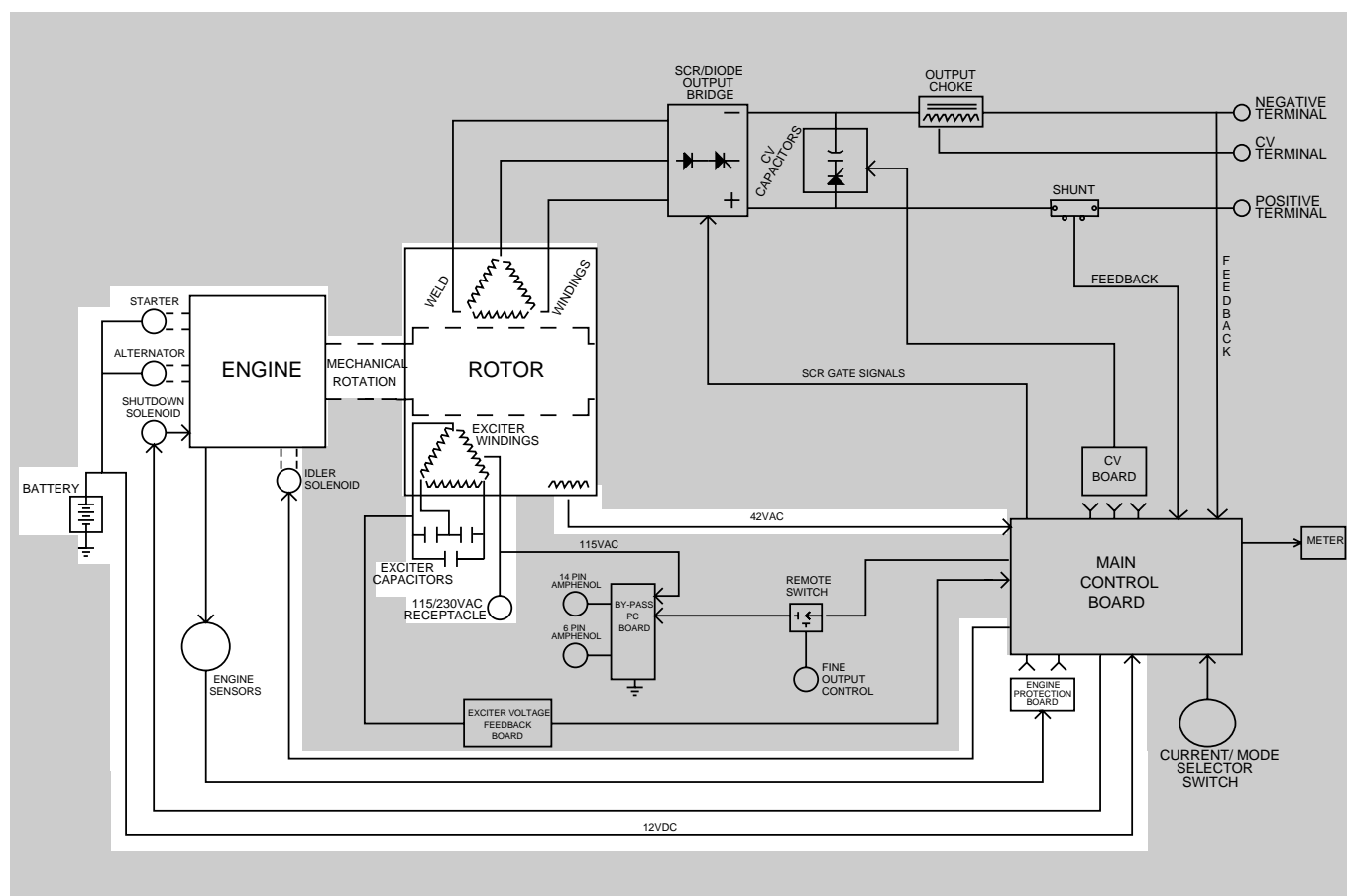


FIGURE E.1 – COMMANDER 400 BLOCK LOGIC DIAGRAM

# THEORY OF OPERATION

FIGURE E.2 – BATTERY, STARTER, ENGINE, ROTOR AND STATOR



## GENERAL DESCRIPTION

The Commander 400 is a diesel engine driven welding power source. The machine uses a brushless asynchronous alternating current generator for DC stick electrode welding and for 120/240 VAC auxiliary standby power. As a generator it can supply up to 10,000 watts of 120/240 volt AC power. As a welder it provides up to 400 amps of DC constant current output in six slope-controlled ranges. In addition a seventh general purpose welding range provides up to 575 amps of constant current welding output.

The stick and wire model has a CV terminal for constant voltage wire welding.

## BATTERY, STARTER, ENGINE, ROTOR AND STATOR

The 12VDC battery powers the engine starter motor and supplies power to the main control board for the engine protection circuitry. The engine's alternator supplies "charging" current for the battery circuit. The battery circuit also provides power through the main

control board for the idler solenoid, which is mechanically coupled to the engine's throttle linkage.

The diesel engine is coupled to a brushless asynchronous three-phase alternating current induction generator. See **Induction Generators**. The excitation or "flashing" voltage is developed in the exciter windings and capacitor configuration. The rotor, which is manufactured by casting aluminum through steel lamination, is mechanically coupled to the engine. Through excitation of this rotating magnet, voltages are produced in the stationary windings of the stator. There are three separate and isolated sets of windings incorporated in the stator lamination. Each set has a different number of turns producing different magnitudes of AC output voltages. These three windings are the three-phase weld winding, the three-phase exciter winding; which is tapped for single phase auxiliary standby power; and the 42VAC single-phase winding, which supplies power to the main control board.

The engine protection circuit shuts the engine off in the event of low oil pressure, engine over temperature, malfunction in the engine's alternator system, or a low fuel condition.

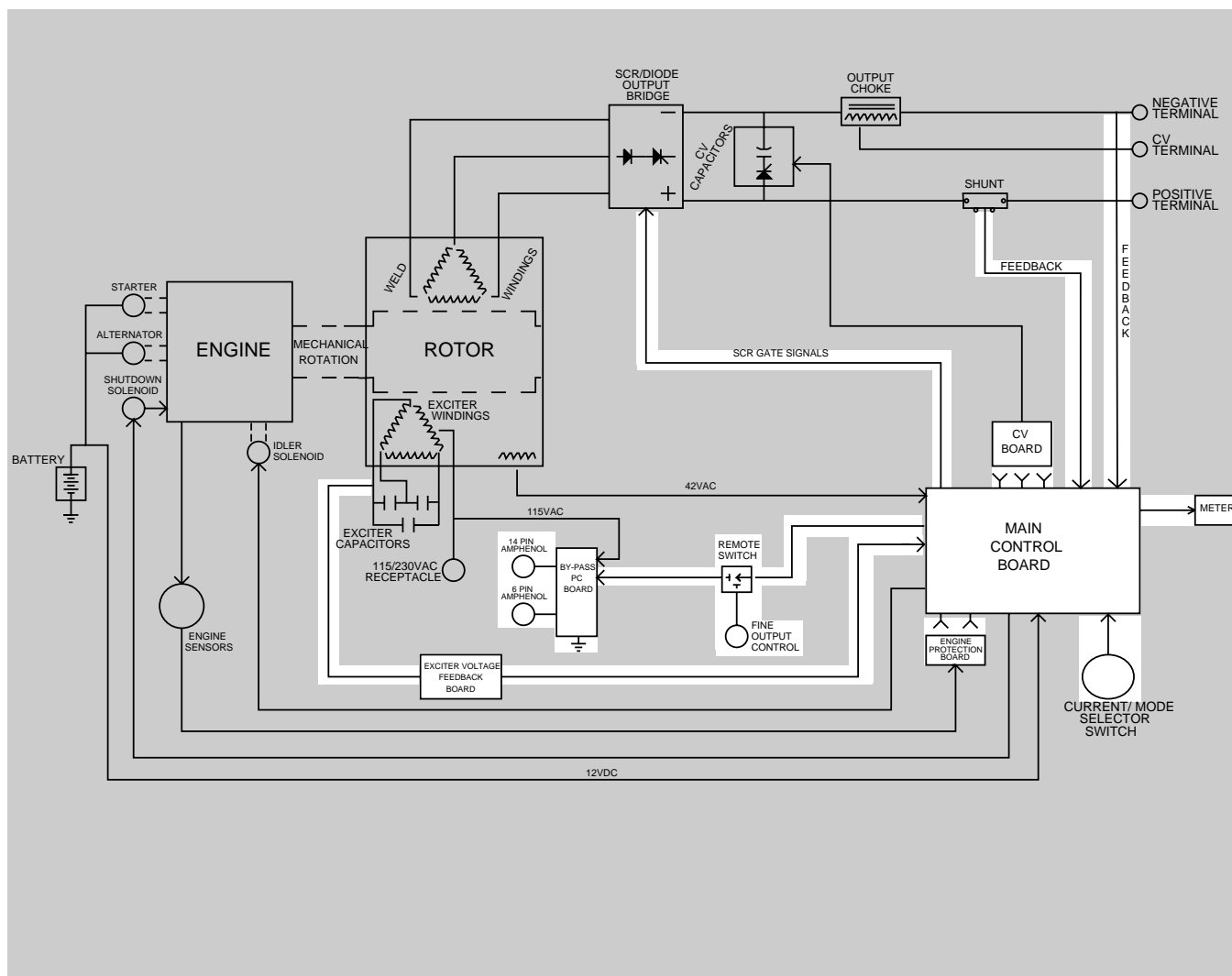
**NOTE:** Unshaded areas of Block Logic Diagram are the subject of discussion.

COMMANDER 400





FIGURE E.3 – EXCITER FEEDBACK, CONTROL BOARD, LOCAL AND REMOTE CONTROL



## EXCITER FEEDBACK, CONTROL BOARD, LOCAL AND REMOTE CONTROL

The exciter voltage is monitored and fed back through the exciter voltage feedback board to the control board. In the event the exciter voltage increases or decreases to an unacceptable level, the engine protection circuit shuts off the engine.

The control board compares the commands of the current/mode selector and the fine output control (or remote control) with the output voltage and current feedback and sends the appropriate SCR gate firing signals to the SCR/Diode bridge.

The Commander 400 is controlled by a high quality microcontroller, which is the main circuit element of the control board.

The control board also supplies operating voltages and control signals to the CV board, the meter board, and the engine protection board.

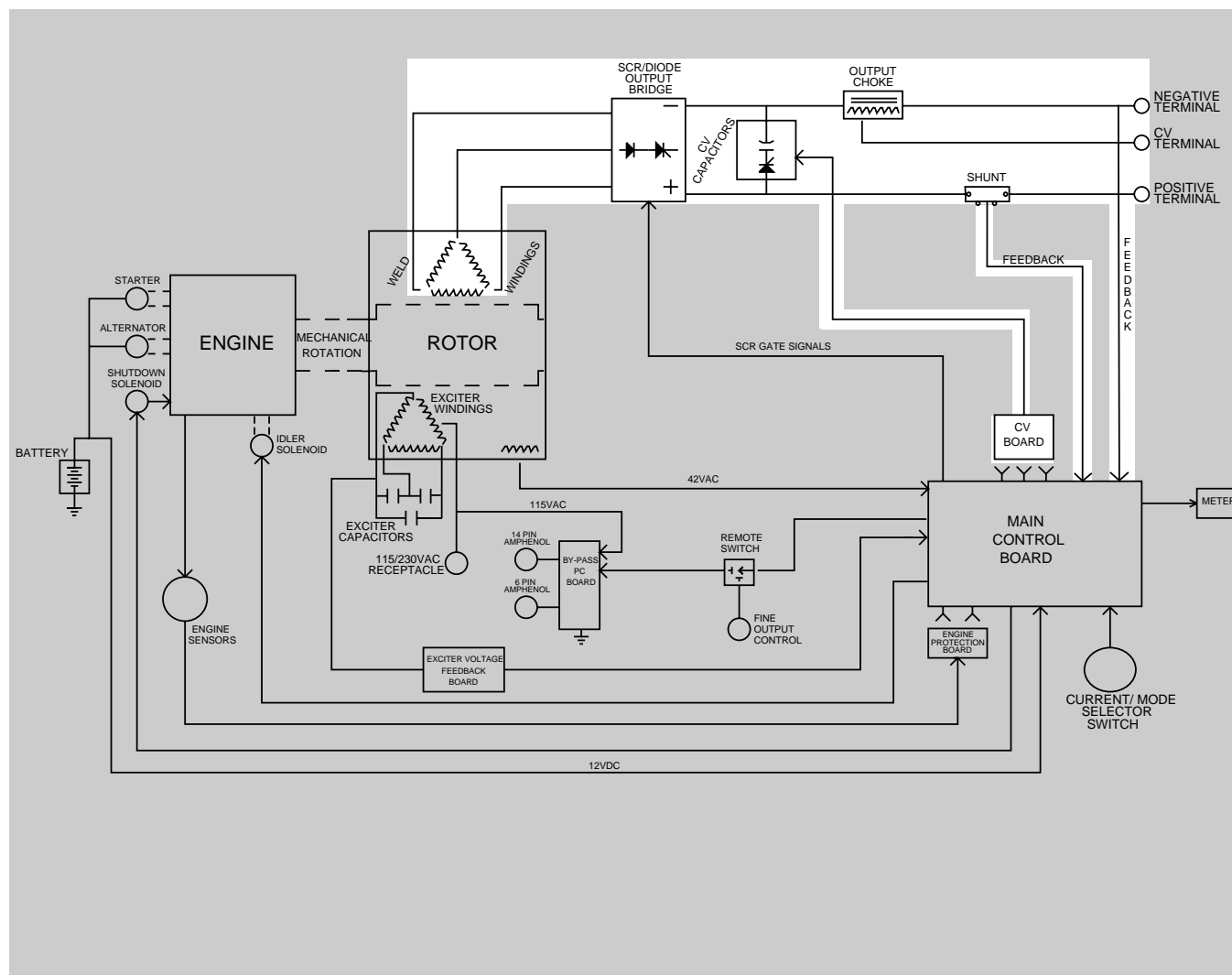
The remote control and contactor signals are fed to the control board through the amphenols and the by-pass board.

**NOTE:** Unshaded areas of Block Logic Diagram are the subject of discussion.

COMMANDER 400



FIGURE E.4 – WELD WINDING, OUTPUT BRIDGE, OUTPUT CHOKE AND CV CAPACITORS



## WELD WINDING, OUTPUT BRIDGE, OUTPUT CHOKE AND CV CAPACITORS

The three-phase AC output that is created in the stator weld winding is connected to the SCR/Diode output bridge where it is rectified and controlled. See **SCR Operation**.

A choke is connected between the negative side of the bridge and the negative output terminal. This large inductor stores energy and provides filtering for the welding output of the Commander 400.

In the constant voltage (CV) mode, the CV capacitors are brought into the welding circuit via an SCR that is activated by the CV board. These capacitors add voltage filtering and help maintain a constant arc voltage at the output terminals.<sup>1</sup>

The shunt, which is in series with the positive output terminal, provides current feedback to the control board.

<sup>1</sup>CV Board and CV Capacitors are present on stick and wire model only.

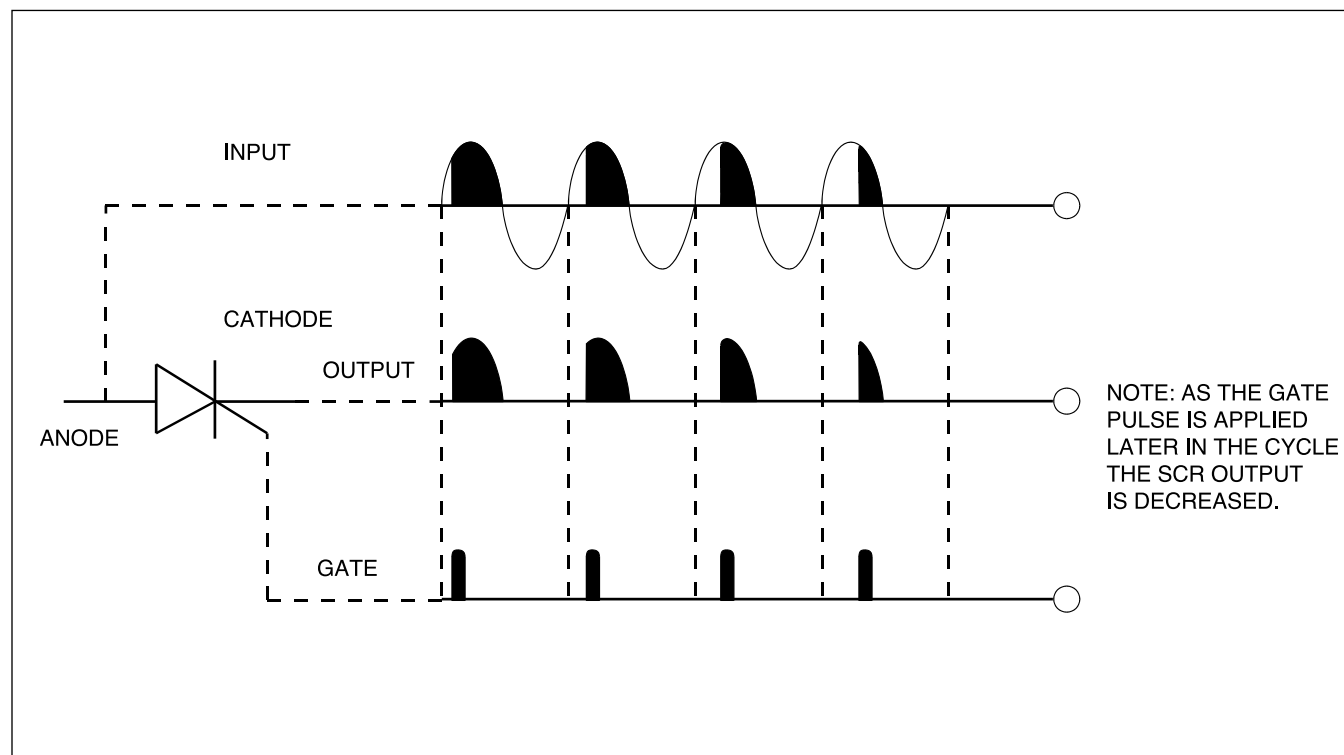
**NOTE:** Unshaded areas of Block Logic Diagram are the subject of discussion.

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# THEORY OF OPERATION

FIGURE E.6 – SCR OPERATION



## SCR OPERATION

A silicon controlled rectifier (SCR) is a three terminal device used to control rather large currents to a load. An SCR acts very much like a switch. When a gate signal is applied to the SCR, it is turned ON and there is current flow from anode to cathode. In the ON state the SCR acts like a closed switch. When the SCR is turned OFF, there is no current flow from anode to cathode and the device acts like an open switch. As the name suggests, the SCR is a rectifier, so it passes current only during positive half cycles of the AC supply. The positive half cycle is the portion of the sine wave in which the anode of the SCR is more positive than the cathode.

When an AC supply voltage is applied to the SCR, the device spends a certain portion of the AC cycle time in the ON state and the remainder of the time in the OFF state. The amount of time spent in the ON state is controlled by the Gate.

An SCR is fired by a short burst of current into the gate. This gate pulse must be more positive than the cathode voltage. Since there is a standard PN junction between gate and cathode, the voltage between these terminals must be slightly greater than 0.6V. Once the SCR has fired it is not necessary to continue the flow of gate current. As long as current continues to flow from anode to cathode, the SCR will remain on. When the anode to cathode current drops below a minimum value, called holding current, the SCR will shut off. This normally occurs as the AC supply voltage passes through zero into the negative portion of the sine wave. If the SCR is turned on early in the positive half cycle, the conduction time is longer, resulting in greater SCR output. If the gate firing occurs later in the cycle, the conduction time is less, resulting in lower SCR output.

INDUCTION GENERATORS

The Commander 400 utilizes a **brushless** Asynchronous Induction Generator to convert mechanical energy into electrical energy. The following is a brief description of an induction generator.

The induction generator is an induction motor driven above the synchronous speed. The rotor conductors pass through the magnetic field of the stator in a direction that converts mechanical energy into electrical energy. Typical alternators (synchronous generators) are not self-excited. An induction generator must be connected in parallel with an electrical system that provides out-of-phase current or reactive power for excitation. The capacitors used in the Commander 400 provide the same reactive power that an induction motor would use for power factor correction. In fact, the amount of reactive power used by an induction generator is equal to that used by an induction motor of the same size.

To summarize, the stand-alone induction generator used in the Commander 400 converts mechanical energy into electrical energy. The electrical energy supplied by the capacitors is transferred magnetically to the rotor. Mechanical energy is supplied to the magnetized rotor in the form of torque and rotational speed. The majority of this energy is magnetically delivered to the stator weld coils.

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# TROUBLESHOOTING & REPAIR

## HOW TO USE TROUBLESHOOTING GUIDE

### ⚠ WARNING

Service and repair should be performed by only Lincoln Electric Factory Trained Personnel. Unauthorized repairs performed on this equipment may result in danger to the technician and machine operator and will invalidate your factory warranty. For your safety and to avoid Electrical Shock, please observe all safety notes and precautions detailed throughout this manual.

This Troubleshooting Guide is provided to help you locate and repair possible machine malfunctions. Simply follow the three-step procedure listed below.

**Step 1. LOCATE PROBLEM (SYMPTOM).** Look under the column labeled "PROBLEM" (SYMPTOMS). This column describes possible symptoms that the machine may exhibit. Find the listing that best describes the symptom that the machine is exhibiting. Symptoms are grouped into four main categories: Output Problems, Engine Problems Function Problems, and Welding Problems.

**Step 2. PERFORM EXTERNAL TESTS.** The second column, labeled "POSSIBLE AREAS OF MISADJUSTMENT(S)", lists the obvious external possibilities that may contribute to the machine symptom. Perform these tests/checks in the order listed. In general, these tests can be conducted without removing the case cover.

**Step 3. PERFORM COMPONENT TESTS.** The last column, labeled "Recommended Course of Action" lists the most likely components that may have failed in your machine. It also specifies the appropriate test procedure to verify that the subject component is either good or bad. If there are a number of possible components, check the components in the order listed to eliminate one possibility at a time until you locate the cause of your problem.

All of the referenced test procedures referred to in the Troubleshooting Guide are described in detail at the end of this section. Refer to the Troubleshooting and Repair Table of Contents to locate each specific Test Procedure. All of the referred to test points, components, terminal strips, etc., can be found on the referenced electrical wiring diagrams and schematics. Refer to the Electrical Diagrams Section Table of Contents to locate the appropriate diagram.

### ⚠ CAUTION

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353.

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# TROUBLESHOOTING & REPAIR

## PC BOARD TROUBLESHOOTING PROCEDURES

### ⚠ WARNING

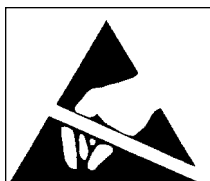


#### **ELECTRIC SHOCK can kill.**

Have an electrician install and service this equipment. Turn the machine OFF before working on equipment. Do not touch electrically hot parts.

Sometimes machine failures appear to be due to PC board failures. These problems can sometimes be traced to poor electrical connections. To avoid problems when troubleshooting and replacing PC boards, please use the following procedure:

1. Determine to the best of your technical ability that the PC board is the most likely component causing the failure symptom.
2. Check for loose connections at the PC board to assure that the PC board is properly connected.
3. If the problem persists, replace the suspect PC board using standard practices to avoid static electrical damage and electrical shock. Read the warning inside the static resistant bag and perform the following procedures:



**ATTENTION**  
Static-Sensitive  
Devices  
Handle only at  
Static-Safe  
Workstations

**Reusable  
Container  
Do Not Destroy**

#### **PC Board can be damaged by static electricity.**

- Remove your body's static charge before opening the static-shielding bag. Wear an anti-static wrist strap. For safety, use a 1 Meg ohm resistive cord connected to a grounded part of the equipment frame.
- If you don't have a wrist strap, touch an unpainted, grounded, part of the equipment frame. Keep touching the frame to prevent static build-up. Be sure not to touch any electrically live parts at the same time.

- Tools which come in contact with the PC Board must be either conductive, anti-static or static-dissipative.

- Remove the PC Board from the static-shielding bag and place it directly into the equipment. Don't set the PC Board on or near paper, plastic or cloth which could have a static charge. If the PC Board can't be installed immediately, put it back in the static-shielding bag.

- If the PC Board uses protective shorting jumpers, don't remove them until installation is complete.

- If you return a PC Board to The Lincoln Electric Company for credit, it must be in the static-shielding bag. This will prevent further damage and allow proper failure analysis.

4. Test the machine to determine if the failure symptom has been corrected by the replacement PC board.

**NOTE:** Allow the machine to heat up so that all electrical components can reach their operating temperature.

5. Remove the replacement PC board and substitute it with the original PC board to recreate the original problem.

- a. If the original problem does not reappear by substituting the original board, then the PC board was not the problem. Continue to look for bad connections in the control wiring harness, junction blocks, and terminal strips.

- b. If the original problem is recreated by the substitution of the original board, then the PC board was the problem. Reinstall the replacement PC board and test the machine.

6. Always indicate that this procedure was followed when warranty reports are to be submitted.

**NOTE:** Following this procedure and writing on the warranty report, "INSTALLED AND SWITCHED PC BOARDS TO VERIFY PROBLEM," will help avoid denial of legitimate PC board warranty claims.

# TROUBLESHOOTING & REPAIR

Observe Safety Guidelines detailed in the beginning of this manual.

## TROUBLESHOOTING GUIDE

PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
Major physical or electrical damage is evident.	1. Contact your local Lincoln Authorized Field Service Facility.	1. Contact the Lincoln Electric Service Department. 1-800-833-9353 (WELD).
No welding output in either CV or Stick modes. Auxiliary power is normal and engine operates normally.	<ol style="list-style-type: none"> <li>Place the Welding Terminals switch in the "ALWAYS ON" position. If the problem is solved, the fault may be in the external control cable (if used), Leads #2 and #4. See the Wiring Diagram.</li> <li>Check the welding cables, clamps, and electrode holder for loose or faulty connections.</li> <li>With the engine at high idle (1900 RPM), and the machine in the general fab tap, Check for the presence of 70VDC at the output terminals of the Commander 400.</li> </ol>	<ol style="list-style-type: none"> <li>Check for loose or faulty connections on the heavy current carrying leads between the output bridge and the output terminals. Also check for broken leads at the weld choke. See the Wiring Diagram.</li> <li>Check the welding terminal switch (S6) and leads 2 &amp; 4 back to J8 pins 2 &amp; 3 of the control board.</li> <li>Check for poor connections at J6 pins 1,2 &amp; 3 molex plug at the control PC board. Also check leads G1,G2 &amp; G3 to each SCR. These are SCR gate drive outputs.</li> <li>Check leads W1 thru W6 for loose or faulty connections. See the wiring diagram.</li> <li>Perform the <b>Stator Voltage Test</b>.</li> <li>Perform the <b>SCR/Diode Bridge Test</b>.</li> <li>Perform the <b>Control Board Power Supply Test</b>.</li> </ol>

### ⚠ CAUTION

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

Commander 400



# TROUBLESHOOTING & REPAIR

## TROUBLESHOOTING GUIDE

Observe Safety Guidelines  
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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
"---" or "CRS" stuck on display when machine is powered up. No welding output in both stick and CV modes. Engine operates normally and auxiliary power is normal.	1. Contact your local Lincoln Authorized Field Service shop.	<ol style="list-style-type: none"> <li>1. Check for loose or faulty connections or wires at the T1, T2, or T3 capacitor connection block and back to the capacitor bank. On machines equipped with L10953-1 Exciter feedback Module Assembly check leads T1, T2 &amp; T3 for faulty connections.</li> <li>2. Check for loose or faulty connections at leads 268, 269, &amp; 270 from the exciter PC board to J4 pins 1, 2, &amp; 3 on the control board.</li> <li>3. Check the exciter waveforms as illustrated in the <b>Oscilloscope Waveforms Section</b>.</li> </ol>
The welding output is low with little or no control of output. The auxiliary power is OK. The engine is operating normal.	<ol style="list-style-type: none"> <li>1. If the remote control unit is not connected to the machine, make sure the Local/Remote switch (S1) is in the "Local" position.</li> <li>2. If a remote control unit is connected, and the machine operates normally when the switch is in the "Local" position, the remote control cable or unit may be faulty. Check or replace.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b>Fine Control Potentiometer Test</b>.</li> <li>2. Perform the <b>Stator Voltage Test</b>.</li> <li>3. Perform the <b>SCR/Diode Bridge Test</b>.</li> </ol>
The machine has low welding output and low auxiliary output.	1. The engine speed may be low. Normal high idle (no load) is 1900 RPM.	<ol style="list-style-type: none"> <li>1. If the speed is low, perform the <b>Engine Throttle Adjustment Test</b>.</li> <li>2. Perform the <b>Stator Voltage Test</b>.</li> <li>3. Perform the <b>Exciter Capacitor Bank Test</b>.</li> <li>4. The engine may have lost horsepower and may need major repairs.</li> </ol>

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Observe Safety Guidelines detailed in the beginning of this manual.

## TROUBLESHOOTING GUIDE

PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
Low or no constant voltage (CV) welding output. Constant current (CC) and the auxiliary power are operating normally.	<ol style="list-style-type: none"> <li>1. Make sure the wire feeder, control cable and welding cables are connected correctly.</li> <li>2. Make sure the range switch is in the correct position.</li> <li>3. Check the heavy current carrying cables associated with the CV output terminal. See the Wiring Diagram.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b>Range Switch Test</b>.</li> <li>2. Check for poor connections at J21 pins 1 &amp; 4 at the CV daughter board. This is CVSCR gate drive output. Will not affect welding in the general fab or pipe taps.</li> <li>3. Check for poor connections along lead #208 at the negative CV output stud and at the J21 pin 6 molex plug at the CV daughter board. This is CV voltage feedback input. Will not affect welding in the general fab or pipe taps.</li> <li>4. Perform the <b>Control Board Power Supply Test</b>.</li> </ol>
The machine powers down within seconds of power up and all lamp indicators on the front panel are lit. "ECL", "ECH", or "CSS" appears on display as machine is shutting down.	<ol style="list-style-type: none"> <li>1. Contact your local Lincoln Authorized Field Service Shop.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check to make sure that the machine has an L10953-1 Exciter Feedback Module Asbly.</li> <li>2. Check for loose or faulty connections or wires at the T1, T2 or T3 capacitor connection block and back to the capacitor bank. On machines equipped with L10953-1 Exciter Feedback Module Asbly check leads T1, T2 and T3 for fault connections.</li> <li>3. Check for loose or faulty connections at leads 268, 269, &amp; 270 from the exciter PC Board to J4 pins 1, 2 &amp; 3 on the control board.</li> <li>4. If possible check exciter waveforms as illustrated in the <b>Oscilloscope Waveforms Section</b>.</li> <li>5. If possible perform the <b>Exciter Voltage Feedback Test</b>.</li> </ol>

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Commander 400



# TROUBLESHOOTING & REPAIR

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Observe Safety Guidelines  
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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>OUTPUT PROBLEMS</b>		
No welding output in either CV or stick modes. Also no auxiliary power. Engine operates normally.	1. Contact your local Lincoln Authorized Field Service Shop.	<ol style="list-style-type: none"> <li>1. Check for loose or faulty connections or wires at the T1, T2 or T3 capacitor connection block and back to the capacitor bank. On machines equipped with L10953-1 Exciter feedback module asbly check leads T1, T2 and T3 for faulty connections. See the Wiring Diagram.</li> <li>2. Perform the <b>Exciter Capacitor Bank Test</b>.</li> <li>3. Check for a short across the weld bridge plates.</li> <li>4. Disconnect leads 3, 5 &amp; 6 from the terminal block located inside the right hand side of the control box. Check for a short across each 115v and 115V/230V receptacle.</li> <li>5. Check fro shorts or opens in the stator by performing the <b>Stator Resistance Test</b>.</li> <li>6. Perform the <b>Control Board Power Supply Test</b>.</li> </ol>
No auxiliary power at receptacles. The engine operates normally and the welding output is normal.	<ol style="list-style-type: none"> <li>1. Check the circuit breakers CB1 thru CB4. Reset if tripped.</li> <li>2. Check the GFCI receptacles. Reset if tripped.</li> <li>3. Check for loose or faulty plugs at the power receptacles.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check the GFCI receptacles and associated wires for loose or faulty connections. See the Wiring Diagram.</li> <li>2. Check the continuity of leads #3, #5, #5A and #6 from the exciter windings to their respective tie points. See the Wiring Diagram.</li> <li>3. Perform the <b>Stator Voltage Test</b>.</li> </ol>

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# TROUBLESHOOTING & REPAIR

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## TROUBLESHOOTING GUIDE

PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>ENGINE PROBLEMS</b>		
Engine will not idle down to low speed. Machine has normal weld and auxiliary power.	<ol style="list-style-type: none"> <li>1. Make sure the Idler switch (S4) is in the "AUTO" position.</li> <li>2. Make sure there is not an external load on either the weld terminals or the auxiliary receptacles.</li> <li>3. Check for mechanical restriction in the solenoid linkage.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b>Idler Solenoid Test</b>.</li> <li>2. Make sure the control board mounting/grounding screws are tight.</li> <li>3. Check leads #226, #227, #237 &amp; #254 for loose or faulty connections. See the Wiring Diagram.</li> <li>4. Check solenoid waveforms as illustrated in the <b>Oscilloscope Waveforms Section</b>.</li> <li>5. Check to make sure that leads #227 &amp; #232 at the B1 &amp; B3 terminals on the control board are not swapped. See the Wiring Diagram.</li> </ol>
Engine will not go to high idle when attempting to weld or use auxiliary power. Output is normal when Idler switch is in the "HIGH" position. Automatic idle function works properly when the auxiliary power is loaded.	<ol style="list-style-type: none"> <li>1. Make sure the welding cables and connections are tight.</li> </ol> <p>NOTE: The automatic idler may not function if the auxiliary power is loaded to less than 150 watts.</p>	<ol style="list-style-type: none"> <li>1. Check the current sensing toroid for loose or faulty connections. CV models only. See the Wiring Diagram.</li> <li>2. Make sure the toroid and lead assembly are assembled correctly. <u>CV models only</u>. See the Wiring Diagram.</li> <li>3. Check the shunt and associated leads for loose or faulty connections. <u>Stick models only</u>.</li> <li>4. The control board may be faulty.</li> </ol>

### CAUTION

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# TROUBLESHOOTING & REPAIR

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Observe Safety Guidelines  
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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>ENGINE PROBLEMS</b>		
The machine goes to low idle but does not stay at low idle.	1. Make sure there is NOT an external load (auxiliary or weld) connected to the Commander 400.	1. The idler solenoid linkage may be misadjusted or damaged. 2. The idler solenoid hold-in circuitry may be faulty. Check leads #237 and #226 for loose or faulty connections. See the Wiring Diagram. 3. Perform the <b>Idler Solenoid Test</b> . 4. Make sure the control board mounting/grounding screws are tight. 5. Check solenoid waveforms as illustrated in the <b>Oscilloscope Waveforms Section</b> . 6. The control board may be faulty. Replace.
The engine will not crank or cranks very slowly.	1. Check for loose, faulty, or corroded battery cable connections. 2. Check the leads and connections at the starter solenoid and the start push button. 3. The battery may be faulty.	1. The starter motor, solenoid or push button may be faulty. Check or replace. 2. The engine may be hard to crank due to a mechanical failure in the engine.

### **⚠ CAUTION**

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Commander 400





# TROUBLESHOOTING & REPAIR

Observe Safety Guidelines detailed in the beginning of this manual.

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>ENGINE PROBLEMS</b>		
The engine cranks but will not start.	<ol style="list-style-type: none"> <li>1. Check for adequate fuel supply.</li> <li>2. Make sure the fuel shut off valve is in the open position (lever is in line with the hose).</li> <li>3. The battery voltage may be too low. If it is less than 11VDC, charge or replace the battery. Check the charging system.</li> <li>4. If the engine temperature light is lit, check the engine cooling system.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check leads #274 &amp; #240A at J50 (exciter voltage plug) for loose or faulty connections. See the Wiring Diagram.</li> <li>2. Perform the <b>Shutdown Solenoid Test</b>.</li> <li>3. Check leads #224, #225, #240 and #262 for loose or faulty connections. See the Wiring Diagram.</li> <li>4. Make sure the control board mounting/grounding screws are tight.</li> <li>5. Check solenoid waveforms as illustrated in the <b>Oscilloscope Waveforms Section</b>.</li> <li>6. Check to make sure that J4 &amp; J23 are not swapped at the control board. See the Wiring Diagram.</li> </ol>
The engine shuts down shortly after start. Initialize sequence is normal (see <b>Initialization Sequence section</b> ).	<ol style="list-style-type: none"> <li>1. Check for adequate fuel supply.</li> <li>2. If any indicator light is lit when the engine shuts down, that particular system has faulted. Check system.</li> <li>3. Check for loose, faulty, or corroded battery cable connections.</li> <li>4. Check the <b>Run/Stop</b> switch and associated leads for loose or faulty connections.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b>Shutdown Solenoid Test</b>.</li> <li>2. If possible check solenoid waveforms as illustrated in the <b>Oscilloscope Waveforms section</b>.</li> <li>3. The control board may be faulty.</li> </ol>

### CAUTION

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

COMMANDER 400



# TROUBLESHOOTING & REPAIR

## TROUBLESHOOTING GUIDE

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>FUNCTION PROBLEMS</b>		
The battery does not stay charged.	<ol style="list-style-type: none"> <li>1. Check for loose, faulty or corroded battery cable connections.</li> <li>2. The battery may be faulty. Check or replace.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b><i>Charging Circuit Test.</i></b></li> </ol>
The Fine Control on the Commander 400 does not work properly.	<ol style="list-style-type: none"> <li>1. Make sure the Remote/Local switch (S1) is in the "LOCAL" position.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b><i>Fine Control Potentiometer Test.</i></b></li> <li>3. The control board may be faulty.</li> </ol>
Remote output control not functioning correctly.	<ol style="list-style-type: none"> <li>1. Make sure the Remote/Local switch (S1) is in the "REMOTE" position.</li> <li>2. The remote control unit or cable may be faulty. Repair or replace.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b><i>Fine Control Potentiometer Test.</i></b></li> <li>2. Check the Remote/Local switch (S1) and associated leads. See the Wiring Diagram.</li> <li>3. The RF Bypass PC Board (CV models) may be faulty. See the Wiring Diagram.  The Remote Protection PC Board (Stick models) may be faulty. See the Wiring Diagram.</li> <li>4. Check amphenols and associated leads. See the Wiring Diagram.</li> </ol>
The wire feeder does not work when connected to the machine's 14 pin amphenol.	<ol style="list-style-type: none"> <li>1. Check the circuit breaker CB5. Reset if tripped.</li> <li>2. The wire feeder control cable may be faulty. Check or replace.</li> <li>3. The wire feeder may be faulty. Check or replace.</li> </ol>	<ol style="list-style-type: none"> <li>1. With the engine at high idle speed: Check for the presence of 115VAC at leads #31 pin "J" and #32 pin "A" at the 14 pin amphenol. If the voltage is missing or low, Check for loose or broken connections. See the Wiring Diagram. Also check CB5 for proper operation.</li> <li>2. The RF bypass board (CV modules only) may be faulty. See the Wiring Diagram.</li> <li>3. Perform the <b><i>Stator Voltage Test.</i></b></li> </ol>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>FUNCTION PROBLEMS</b>		
The welding arc is "cold." The engine runs normally. The auxiliary power is normal.	<ol style="list-style-type: none"> <li>1. Check for loose or faulty connections at the weld output terminals and welding cable connections.</li> <li>2. The welding cables may be too long or coiled, causing an excessive voltage drop.</li> <li>3. Check to make sure that the machine settings match the weld application.</li> <li>4. If a remote control unit is not connected to the machine, make sure the <b>Local/Remote</b> switch (S1) is in the "LOCAL" position.</li> <li>5. If the remote control unit is connected, and the machine operates normally when the switch is in the "LOCAL" position, the remote control cable or unit may be faulty. Check or replace.</li> </ol>	<ol style="list-style-type: none"> <li>1. Using a voltmeter, check for the correct OCV at the weld terminals. If the correct voltage is present, then check for loose connections on the heavy current carrying leads inside the machine. See the Wiring Diagram.</li> <li>2. If the OCV is low, perform the <b>Engine Throttle Adjustment Test</b>.</li> <li>3. Perform the <b>SCR/Diode Bridge Test</b>.</li> <li>4. Perform the <b>Stator Voltage Test</b>.</li> <li>5. Perform the <b>Range Switch Test</b>.</li> <li>6. Perform the <b>Fine Control Potentiometer Test</b>.</li> <li>7. Check for poor connections at the J1 molex plug at the control board and at the shunt. Also, perform the <b>Shunt Calibration Test</b>.</li> <li>8. Check for poor connections along lead #204A at the diode bridge and at J6 pin 4 molex at the control pc board. This is control board common.</li> <li>9. Check for poor connections at J6 pins 1, 2 &amp; 3 molex plug at the control board. Also check leads G1, G2 &amp; G3 to each SCR. These are SCR gate drive outputs.</li> <li>10. Check for poor connections along lead #207 at the negative CC output stud, and at the J6 pin 10 molex plug at the control board. This is CC arc voltage feedback input. Will not affect welding in the CV tap.</li> </ol>

### ⚠ CAUTION

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
WELDING PROBLEMS		
<p>The welding arc is “cold.” The engine runs normally. The auxiliary power is normal. <b>(Continued)</b></p>		<p>11. Check for poor connection at J21 pins 1 &amp; 4 at the CV daughter board. This is CVSCR gate drive output. Will not affect welding in the general fab or pipe taps.</p> <p>12. Check for poor connection along lead #208 at the negative CV output stud and at J21 pin 6 molex plug at the CV daughter board. This is CV voltage feedback input. Will not affect welding in the general fab or pipe taps.</p> <p>13. Check the weld &amp; CV chokes (if so equipped) for turn to turn shorts.</p> <p>14. Check all waveforms as illustrated in the <b><i>Oscilloscope Waveforms Section.</i></b></p> <p>15. Perform the <b><i>Control Board Power Supply Test.</i></b></p>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>WELDING PROBLEMS</b>		
The welding arc is "hot", "spattery", "cannonballs" or "flares up". The engine runs normally. The auxiliary power is normal.	<ol style="list-style-type: none"> <li>1. Check to make sure that the machine settings match the weld application.</li> <li>2. If the remote control unit is not connected to the machine, make sure the Local/Remote switch (S1) is in the "Local" position.</li> <li>3. If a remote control unit is connected, and the machine operates normally when the switch is in the "Local" position, the remote control cable or unit may be faulty. Check or replace.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform the <b>Range Switch Test</b>.</li> <li>2. Perform the <b>Fine Control Potentiometer Test</b>.</li> <li>3. Check for poor connections at the J1 molex plug at the control board. Also, perform the <b>Shunt Calibration Test</b>.</li> <li>4. Check for poor connections at J4 pins 1, 2, 3, 6, &amp; 7 at the control board. Also, perform the <b>Exciter Voltage Feedback Test</b>.</li> <li>5. Check for poor connections along lead #207 at the negative CC output stud, and at J6 pin 10 molex plug at the control board. This is CC arc voltage feedback input. Will not effect welding in the CV tap.</li> <li>6. Check for poor connections along lead #204A at the diode bridge and at J6 pin 4 molex plug at the control board. This is control board common.</li> <li>7. Check for poor connection along lead #208 at the negative CV output stud and at J21 pin 6 molex plug at the CV daughter board. This is CV voltage feedback input. Will not affect welding in the general fab or pipe taps.</li> <li>8. Check for poor connection at J21 pins 1 &amp; 4 at the CV daughter board. This is CVSCR gate drive output. Will not affect welding in the general fab or pipe taps.</li> <li>9. Check the weld &amp; CV chokes (if so equipped) for turn to turn shorts.</li> </ol>

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PROBLEMS (SYMPTOMS)	POSSIBLE AREAS OF MISADJUSTMENT(S)	RECOMMENDED COURSE OF ACTION
<b>WELDING PROBLEMS</b>		
The welding arc is "hot", "spattery", "cannonballs" or "flares up". The engine runs normally. The auxiliary power is normal. <b>(Continued)</b>		<p>10. Check all waveforms as illustrated in the <b><i>Oscilloscope Wave forms Section.</i></b></p> <p>11. Perform the <b>Control Board Power Supply Test.</b></p>
Machine shuts down while arc gouging and all lamp indicators on front panel are lit. "ECL", "ECH", or "CCS" appears on display as machine is shutting down.	<ol style="list-style-type: none"> <li>1. Check to make sure that the machine settings match the weld application.</li> <li>2. Check to make sure the proper carbon arc rod is being used. The maximum carbon arc rod for the Commander 400 is 5/16".</li> <li>3. Attempt to arc gouge at a lesser current, if the application will permit.</li> <li>4. If the machine shuts down while arc gouging in the general fab tap, use the CV tap instead. This is also an acceptable process.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check for poor connections at J4 pins 1, 2, 3, 6 &amp; 7 at the control pc board. Also, perform the <b><i>Exciter Voltage Feedback Test.</i></b></li> <li>2. Check for loose or faulty connections or wires at the T1, T2, or T3 capacitor connection block and back to the capacitor bank. On machines equipped with L10953-1 Exciter Feedback module asbly, check leads T1, T2, &amp; T3 for faulty connections.</li> <li>3. Check for loose or faulty connections at leads 268, 269 &amp; 270 from the exciter pc board to J4 pins 1, 2 &amp; 3 on the control board.</li> <li>4. Perform the <b><i>Exciter Capacitor Bank Test.</i></b></li> <li>5. Check for poor connections at the J1 molex plug at the control pc board. Also, perform the <b><i>Shunt Calibration Test.</i></b></li> <li>6. Perform the <b><i>Engine Throttle Adjustment Test.</i></b></li> <li>7. Check exciter waveforms as illustrated in the <b><i>Oscilloscope Waveforms Section.</i></b></li> </ol>

### ⚠ CAUTION

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

COMMANDER 400



COMMANDER 400 INITIALIZATION SEQUENCE  
AND ERROR CODE EXPLANATIONS

When the Commander 400 is started, the display flashes several messages during initialization. They usually go by so fast you cannot see them. Each message correlates to an initialization test that the microcontroller program runs. No message should be present for more than a few seconds before the next message appears. If any of these initialization messages remain on the display, there is a problem. The microcontroller's program will not advance past that test.

The initialization period is over immediately after the "---" disappears from the display. Once past the initialization, under normal circumstances, the unit displays a welding current preset determined by the position of the front panel control knobs and switches. If a later control board (G2713-2 or -3 is in place, the message "cdr 400 rEAdy" scrolls across the display. Initialization is over after this message finishes scrolling. In the "Stick & Wire" model a preset voltage or actual voltage, as well as current, may be displayed after initialization.

If the microcontroller detects an error, the error code will show on the display first and then the unit may shut down. Use the "Error Code Explanations" on the following pages to aid in troubleshooting diagnosis.

If the unit begins to shut down first and then the error code appears, this is not a microcontroller initiated shutdown. In this case the unit has shut down due to lack of fuel, engine failure, etc.



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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-1 CONTROL BOARD

ERROR CODES DURING INITIALIZATION SEQUENCE	DEFINITION / SYMPTOM	CORRECTIVE ACTION
300	Program is stuck in ROM/RAM check.	Replace control board.
bAd uP	ROM/RAM is corrupt.	Replace control board.
400	Program is stuck in power supply stabilization.	Perform the <b>Control Board Power Supply Test</b> .
600	Program is stuck in register initialization and Interrupt enables.	Replace control board.
700	Program is stuck in calibration constant loading.	Replace control board.
500 or ---	<p>The processor is not getting good initial zero crosses. The program waits for 32 clean crosses and then waits for frequency to get between 55 and 65 HZ.</p> <p>or</p> <p>Program is stuck waiting for program stabilization and loading of exciter voltage register table.</p>	<p>Check exciter voltage waveforms as illustrated in the <b>Oscilloscope Waveforms Section</b>.</p> <p>Perform the <b>Stator Voltage Exciter Winding Test</b>.</p> <p>Perform the <b>Engine Throttle Adjustment Test</b>.</p> <p>Perform the <b>Exciter Capacitor Bank Test</b>.</p> <p>Check leads #268, #269, &amp; #270 from J50 to J4 at the control board for loose or faulty connections. Also check the T1, T2, &amp; T3 lead connections from the exciter module to the stator and capacitor bank leads.</p>

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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-1 CONTROL BOARD

ERROR CODES DURING INITIALIZATION SEQUENCE	DEFINITION / SYMPTOM	CORRECTIVE ACTION
<p>CSS</p> <p>or</p> <p>ECL</p>	<p>The processor is not receiving zero cross signals properly or the engine RPM is out of range.</p> <p>or</p> <p>The exciter voltage is out of range (greater than 550 or less than 140VAC).</p>	<p>Check exciter voltage waveforms as illustrated in the <b><i>Oscilloscope Waveforms Section.</i></b></p> <p>Perform the <b><i>Stator Voltage Exciter Winding Test.</i></b></p> <p>Perform the <b><i>Engine Throttle Adjustment Test.</i></b></p> <p>Perform the <b><i>Exciter Capacitor Bank Test.</i></b></p> <p>Check leads #268, #269, &amp; #270 from J50 to J4 at the control board for loose or faulty connections. Also check the T1, T2, &amp; T3 lead connections from the Exciter Module to the stator and capacitor bank leads.</p>

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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-1 CONTROL BOARD

ERROR CODES DURING INITIALIZATION SEQUENCE	DEFINITION / SYMPTOM	CORRECTIVE ACTION
LCH	The output current is too high (greater than 750 amps for more than 1 second).	<p>The machine may be “over loaded.” Remove any external loads. If the problem persists with no external load, check the shunt leads and associated connections to the control board. See the Wiring Diagram. Perform the <b>SCR/Diode Rectifier Bridge Test</b>.</p> <p>If the above procedures do not reveal the problem, the control board may be faulty.</p>
Err	XIRQ error (illegal external interrupt request).	<p>If a High Frequency unit is being used, make sure it is connected properly. There may be high frequency intrusion from another source in the immediate area. Remove all possible forms of RF intrusion.</p> <p>If the problem persists, the control board may be faulty.</p>

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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-1 CONTROL BOARD

ERROR CODES DURING INITIALIZATION SEQUENCE	DEFINITION / SYMPTOM	CORRECTIVE ACTION
<p>Ert</p> <p>Esi</p> <p>EIO</p> <p>ECP</p> <p>ECE</p> <p>EO5</p> <p>IC3</p>	<p>RTI error (illegal return from interrupt).</p> <p>SWI error (illegal software interrupt request).</p> <p>IOT error (illegal op code trap).</p> <p>COP time-out error.</p> <p>CME error (slow or stopped processor clock).</p> <p>OC5 unintended execution.</p> <p>IC3 unintended execution.</p>	<p>If a High Frequency unit is being used, make sure it is connected properly. There may be high frequency intrusion from another source in the immediate area. Remove all possible forms of RF intrusion.</p> <p>If the problem persists, the control board may be faulty.</p>
<p>SS?</p>	<p>Invalid range control switch position.</p>	<p>Check for proper selector switch/handle alignment. Check the selector switch and associated wiring. See the Wiring Diagram. If the problem persists, the control board may be faulty.</p>

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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-2 or -3 CONTROL BOARD

ERROR CODES DURING INITIALIZATION SEQUENCE	DEFINITION / SYMPTOM	CORRECTIVE ACTION
uP	Program is stuck in ROM/RAM check.	Replace control board.
bAd uP	ROM/RAM is corrupt.	Replace control board.
CAL	Program is stuck in calibration constant loading.	Replace control board.
CrS	<p>The processor is not getting good initial zero crosses. Program waits for 32 clean crosses and then waits for frequency to get between 55 and 65 HZ.</p> <p>Program is stuck waiting for program stabilization and loading of exciter voltage register table.</p>	<p>Check exciter voltage waveforms as illustrated in the <b>Oscilloscope Waveforms Section</b>.</p> <p>Perform the <b>Stator Voltage Exciter Winding Test</b>.</p> <p>Perform the <b>Engine Throttle Adjustment Test</b>.</p> <p>Perform the <b>Exciter Capacitor Bank Test</b>.</p> <p>Check leads #268, #269, &amp; #270 from J50 to J4 at the control board for loose or faulty connections. Also check the T1, T2, &amp; T3 lead connections from the Exciter Module to the stator and capacitor bank leads.</p>

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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-2 or -3 CONTROL BOARD

ERROR CODES DURING INITIALIZATION SEQUENCE	DEFINITION / SYMPTOM	CORRECTIVE ACTION
SSr	Processor is not reading a valid range control switch position.	<p>Check for proper selector switch/handle alignment.</p> <p>Perform the Range Switch Test.</p>
EHC	The exciter voltage level is too high (greater than 550VAC).	<p>Check the exciter voltage waveforms as illustrated in the Oscilloscope Waveforms Section.</p> <p>Perform the Stator Voltage Exciter Winding Test.</p>
ECL	The exciter voltage level is too low (less than 140VAC).	<p>Perform the Engine Throttle Adjustment Test.</p> <p>Perform the Exciter Capacitor Bank Test.</p>
CSS	The processor is not receiving zero cross signals properly or the engine RPM is too high.	<p>Check leads #268, #269 &amp; #270 from J50 to J4 at the control board for loose or faulty connections. Also check the T1, T2, &amp; T3 lead connections from the exciter module to the stator and capacitor bank leads.</p>

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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-2 or -3 CONTROL BOARD

ERROR CODES WHILE RUNNING	DEFINITION / SYMPTOM	CORRECTIVE ACTION
LCH	The output current is too high (greater than 750 amps for more than 1 second).	The machine may be “over loaded.” Remove any external loads. If the problem persists with no external load, check the shunt leads and associated connects to the control board. See the Wiring Diagram. Perform the <b>SCR/Diode Rectifier Bridge Test</b> . If the above procedures do not reveal the problem, the control board may be faulty.
Err	XIRQ error (illegal external interrupt request).	If a High Frequency unit is being used, make sure it is connected properly. There may be high frequency intrusion from another source in the immediate area. Remove all possible forms of RF intrusion. If the problem persists, the control board may be faulty.

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# TROUBLESHOOTING & REPAIR

## COMMANDER 400 WITH G2713-2 or -3 CONTROL BOARD

ERROR CODES WHILE RUNNING	DEFINITION / SYMPTOM	CORRECTIVE ACTION
LFL	Unit has shut down because of low fuel.	Add more fuel. If there is less than half a tank of fuel, check for proper operation of the fuel float. If the float is at the top of the tank, the resistance across its terminals should be less than 100 ohms. If the float is on the bottom of the tank, the resistance across its terminals should be greater than 175 ohms. If the float is OK, check the leads and connections between the float, the fuel gauge and the engine protection board. See the Wiring Diagram. If the above checks do not reveal the problem, the engine protection board may be faulty.
SS?	Invalid range control switch position.	Check for proper selector switch/handle alignment. Check the selector switch and associated wiring. See the Wiring Diagram. If the problem persists, the control board may be faulty.

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TROUBLESHOOTING & REPAIR

COMMANDER 400 WITH G2713-2 or -3 CONTROL BOARD

ERROR CODES WHILE RUNNING	DEFINITION / SYMPTOM	CORRECTIVE ACTION
Ert	RTI error (illegal return from interrupt).	<p>If a High Frequency unit is being used, make sure it is connected properly. There may be high frequency intrusion from another source in the immediate area. Remove all possible forms of RF intrusion.</p> <p>If the problem persists, the control board may be faulty.</p>
Esi	SWI error (illegal software interrupt request).	
EIO	IOT error (illegal op code trap).	
ECP	COP time-out error.	
ECE	CME error (slow or stopped processor clock).	
EO5	OC5 unintended execution.	
IC3	IC3 unintended execution.	

TROUBLESHOOTING & REPAIR

COMMANDER 400 WITH G2713-2 OR -3 CONTROL BOARD

ERROR CODES WHILE RUNNING	DEFINITION / SYMPTOM	CORRECTIVE ACTION
ECH	The exciter voltage is too high (greater than 550 VAC).	Check exciter voltage waveforms as illustrated in the <b><i>Oscilloscope Waveforms Sections.</i></b>
ECL	The exciter voltage is too low (less than 140 VAC).	Perform the <b><i>Stator Voltage Exciter Winding Test.</i></b> Perform the <b><i>Engine Throttle Adjustment Test.</i></b>
CSS	The processor is not receiving zero cross signals properly or the engine RPM is too high.	Perform the <b><i>Exciter Capacitor Bank Test.</i></b> Check leads #268, #269, & #270 from J50 to J4 at the control board for loose or faulty connections. Also check the T1, T2, & T3 lead connections from the Exciter Module to the stator and capacitor bank leads.

# TROUBLESHOOTING & REPAIR

## CASE COVER REMOVAL AND REPLACEMENT PROCEDURE

### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

This procedure will aid the technician in the removal and replacement of the case sheet metal covers.

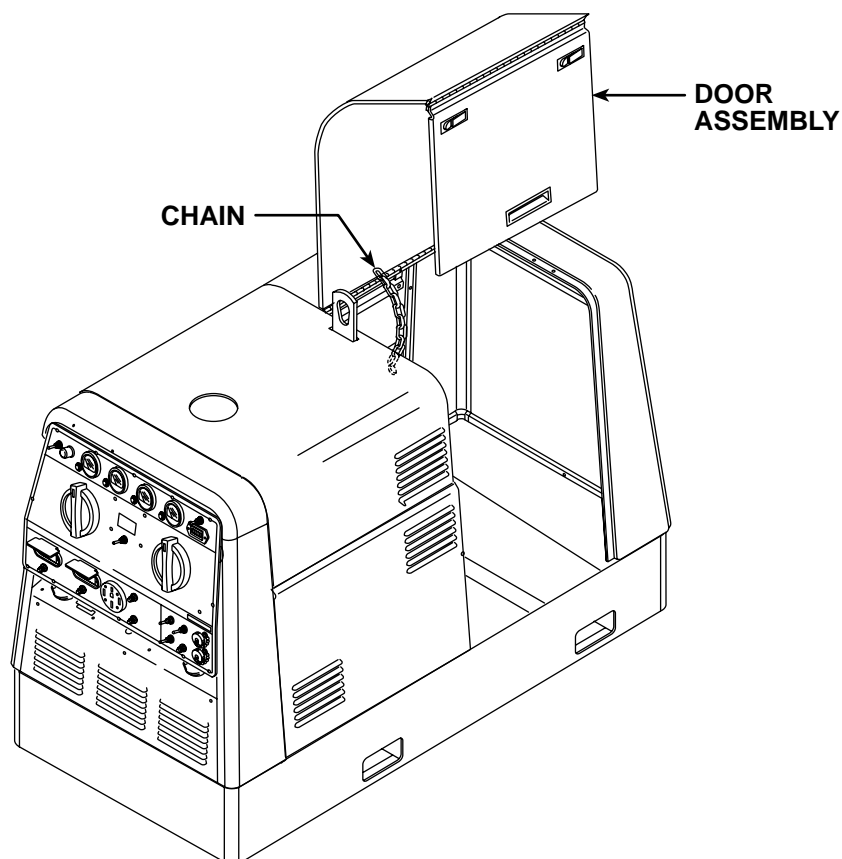
### MATERIALS NEEDED

3/8" Nut driver or Socket Wrench  
7/16" Wrench  
5/16" Nut Driver

This procedure takes approximately 35 minutes to perform.

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**CASE COVER REMOVAL AND REPLACEMENT PROCEDURE** *(continued)***FIGURE F.1 – DOOR CHAIN REMOVAL****PROCEDURE**

1. Turn the engine off.
2. Unlatch and open engine service access door.
3. Using the 7/16" wrench, remove the chain from the door assembly. See Figure F.1

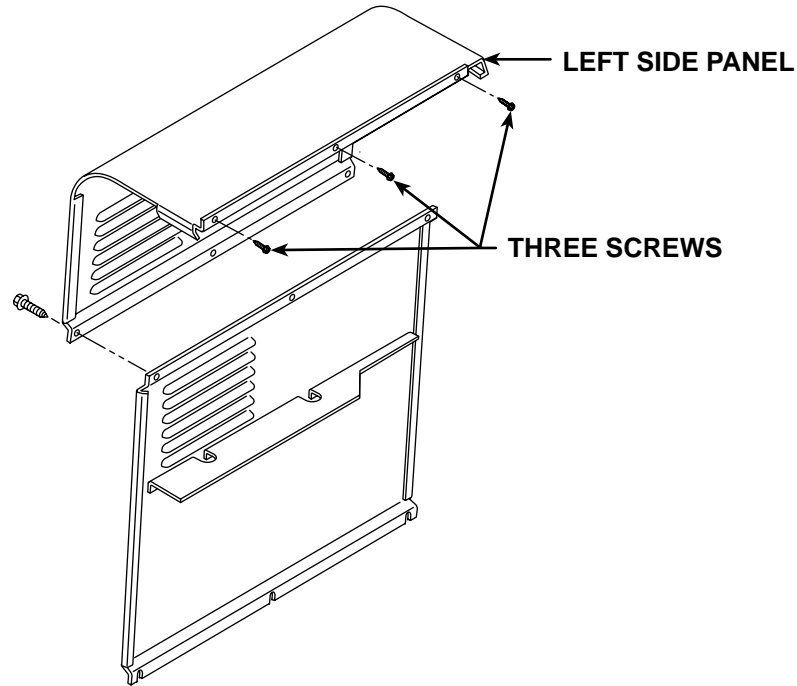
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## TROUBLESHOOTING & REPAIR

### CASE COVER REMOVAL AND REPLACEMENT PROCEDURE *(continued)*

4. Using the 3/8" wrench, remove the three screws holding the door assembly to the left side panel. See Figure F.2.

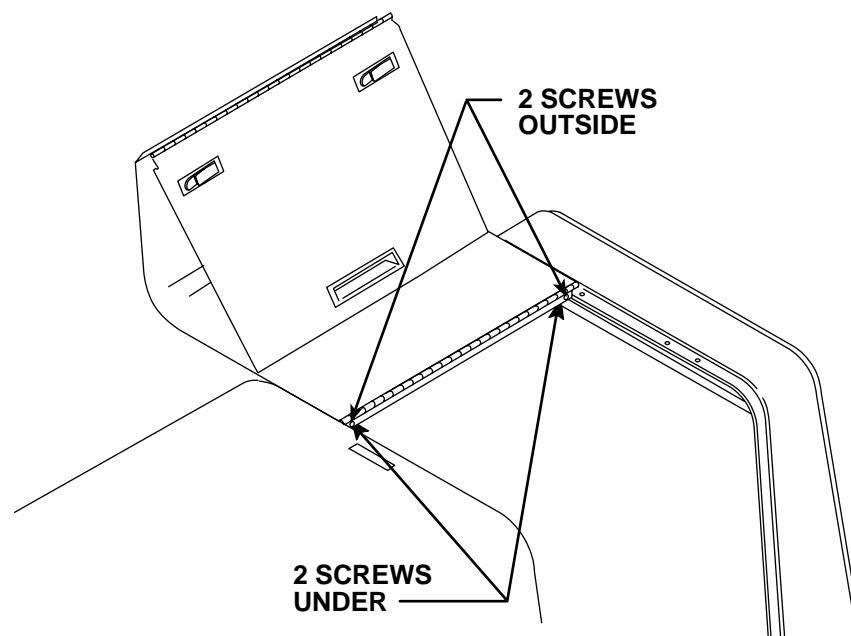
FIGURE F.2 - DOOR ASSEMBLY/LEFT SIDE PANEL SCREW LOCATIONS



5. Using the 3/8" wrench, remove the two screws under the hinge. While supporting the door assembly, remove the two screws

at the ends of the hinge. See Figure F.3. When these screws are removed, the door assembly will be free to fall.

FIGURE F.3 - DOOR HINGE SCREW LOCATIONS



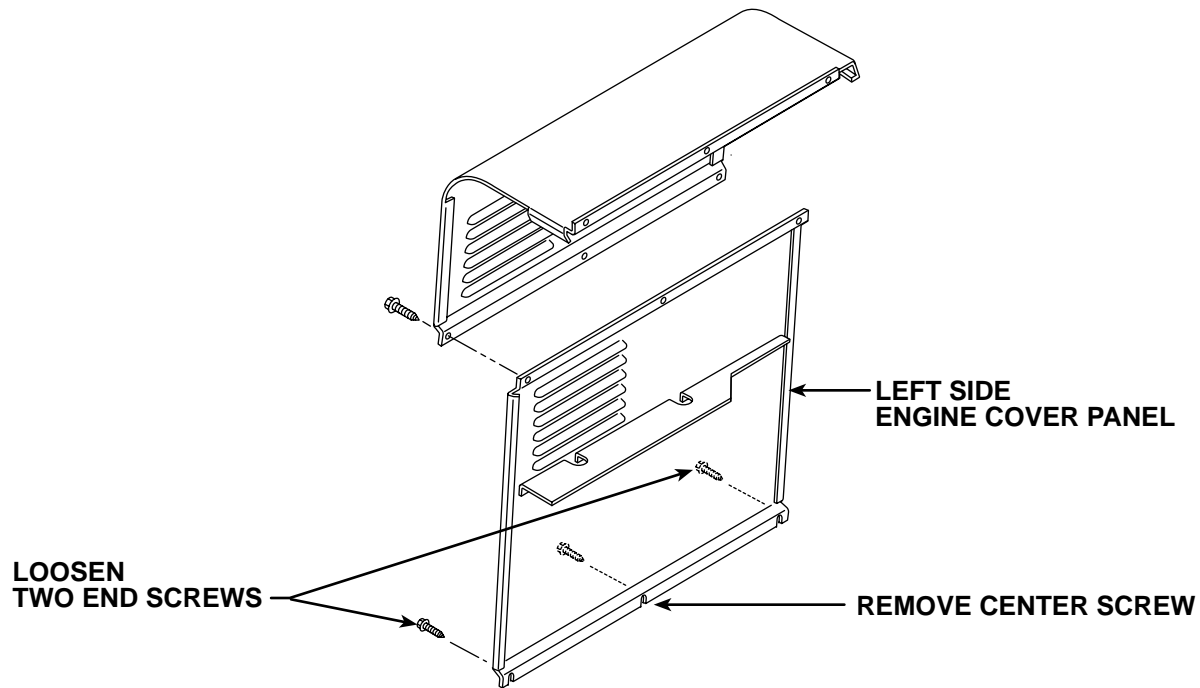
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## CASE COVER REMOVAL AND REPLACEMENT PROCEDURE *(continued)*

6. Carefully lift the door assembly from the machine.
7. Using the 3/8" wrench, loosen the two bottom end screws from the left side engine cover panel. See Figure F.4. Remove the center screw. Remove the panel.

FIGURE F.4 - LEFT SIDE ENGINE COVER REMOVAL

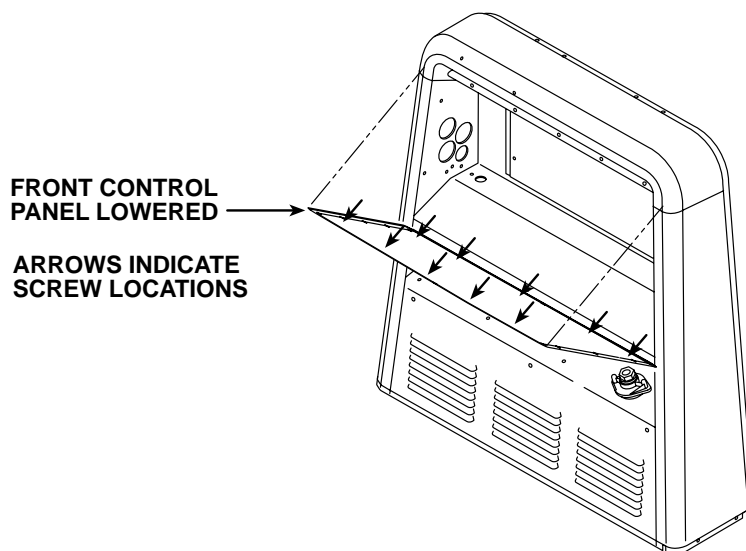


8. Using the 3/8" wrench, remove the screws from the front roof assembly.
9. Remove the fuel cap and rubber seal. Carefully lift and remove the front roof assembly. Replace the fuel cap.
10. Remove the screws from the lower front left and right side panels. The bottom end screws need only to be loosened.
11. Remove the panels.

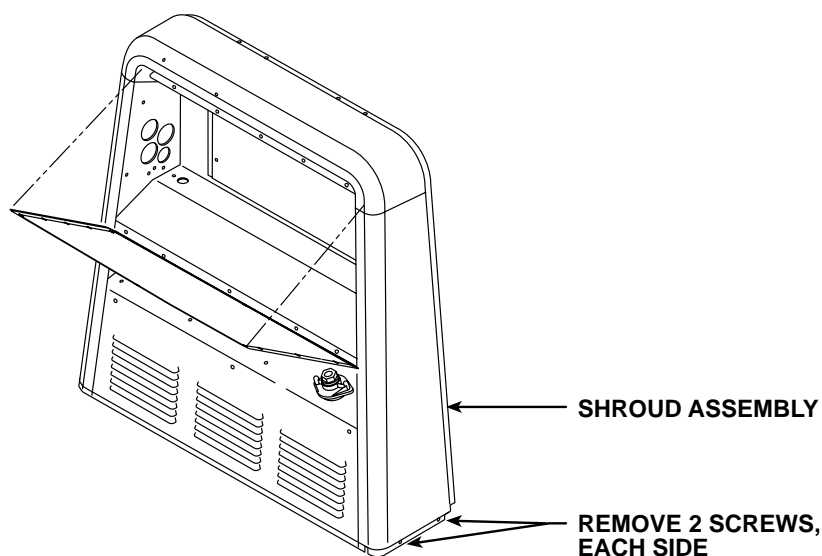


**CASE COVER REMOVAL AND REPLACEMENT PROCEDURE** *(continued)***FRONT SHROUD REMOVAL  
PROCEDURE**

1. Using the 5/16" nut driver, remove the screws from the front control panel assembly. Do NOT remove the phillips head screws. Lower the panel. See Figure F.5.

**FIGURE F.5 – FRONT CONTROL PANEL REMOVAL**

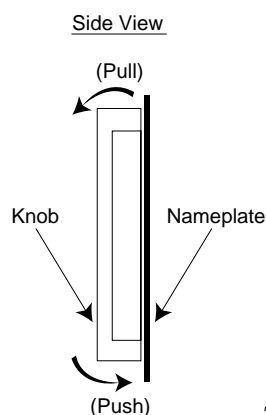
2. Using the 5/16" nut driver, remove the four screws from the left and right sides of the shroud assembly. See Figure F.6.

**FIGURE F.6 – SHROUD ASSEMBLY SCREW REMOVAL - SIDES****COMMANDER 400**

# TROUBLESHOOTING & REPAIR

## CASE FRONT KNOBS - REMOVAL AND REPLACEMENT PROCEDURE

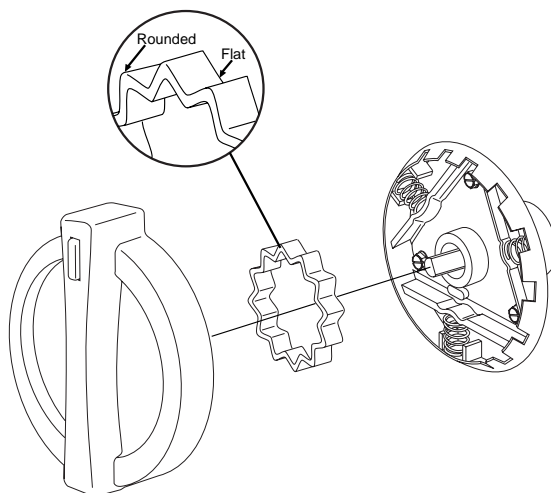
### Removal



Removal:

1. Rotate the handle portion of the knob to an approximate vertical orientation (switch detent may position handle a few degrees off vertical). This orientation should be noted and repeated at replacement for proper "D" shaft orientation.
2. With one hand, grasp the very bottom of vertical handle and push towards the machine nameplate and pull down. At the same time and with the other hand, grasp the very top of the handle and pull the top edge of the knob away from the machine nameplate. The knob should "peel" away from the nameplate and the white nylon holding fingers of the knob base, from top to bottom.

### Replacement



Replacement:

1. If the white nylon cam of the detent mechanism is removed from it's spring loaded base by the above procedure or intentionally, it should be returned before the knob replacement is attempted. Press the cam into it's spring loaded holder so it sets flat and flush (Selector Switch Only).
2. Orientate the knob handle to the vertical as noted above and position the knob over the base, centered and parallel.
3. Press the knob onto the "D" shaft and white nylon holding fingers, maintaining the parallel position. The knob should "click" into place and should not pull off with normal operation.

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## IDLER SOLENOID TEST

### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

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### TEST DESCRIPTION

This test will determine if the idler solenoid is capable of functioning when it is energized with 12VDC.

### MATERIALS NEEDED

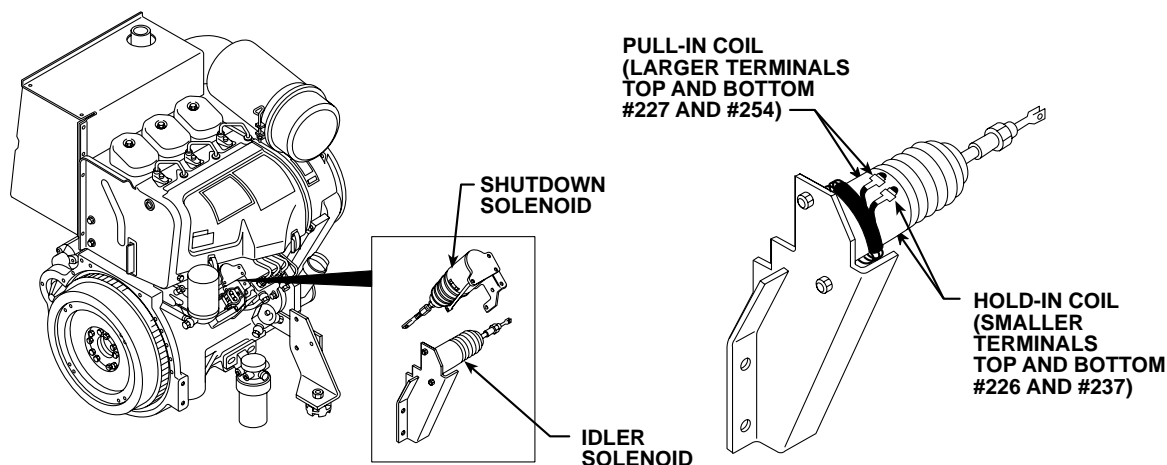
- External 12VDC supply ( 30 amps required)
- Wiring Diagram
- Volt/Ohmmeter

This procedure takes approximately 40 minutes to perform.

# TROUBLESHOOTING & REPAIR

## IDLER SOLENOID TEST *(continued)*

FIGURE F.8 – IDLER SOLENOID LEAD TERMINALS



### TEST PROCEDURE

1. Turn the engine off.
2. Unlatch, lift and secure the right side engine service access door. Using a 5/16", open the control panel and tilt out. Remove the control board cover.
3. Check the pull-in coil resistance by disconnecting lead #227 from the B1 terminal at the control board and measuring the resistance from lead #227 to the ground screw at the control board. Normal coil resistance is approximately 0.4 ohms. Reconnect lead #227 to the B1 terminal at the control board.

Check the hold-in coil resistance by disconnecting J3 from the control board and measuring across pins 3 & 4. Normal coil resistance is approximately 20 ohms. Reconnect J3 at the control board.

If either coil resistance is incorrect, the wiring may be faulty. Inspect the solenoid leads for faulty or loose connections.

If the lead connections are OK, recheck the coil resistance directly across the solenoid. If the coil resistances are incorrect, the solenoid may be faulty. Replace.

4. Using the external 12VDC voltage supply, apply 12VDC to the larger idler solenoid terminals (#227+ to #254-). The solenoid should activate.

### ⚠ CAUTION

When the solenoid activates, remove the voltage supply immediately. Do not leave the external supply connected to terminals #227 and #254 for longer than three seconds. Component damage could result.

The solenoid should deactivate when the 12VDC supply is removed.

5. If the solenoid does not operate properly, check for a mechanical restriction in the linkage.
6. Using the external 12VDC voltage supply, apply 12VDC to the smaller idler solenoid terminals for the hold-in coil (#226+ to #237-). Push in the solenoid plunger. With 12VDC applied to the hold-in coil, the plunger should stay in until the 12VDC is removed.
7. If the linkage is intact and the solenoid does not operate correctly when 12VDC is applied, the solenoid may be faulty. Replace.
8. Replace the harness leads to the correct terminals. See Figure F. 8 and the Wiring Diagram. Replace any previously removed wire wraps.
- 8a. Using the control PC board layout, locate Q21 on the control board. Scrape the environmental coating from all three legs of the device, and check the resistance between all three legs. If there is continuity between any of the legs, Q21 is bad. Replace the control PC board.
9. Close and secure the right side engine service access door. Replace the control board and close the control panel.

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# TROUBLESHOOTING & REPAIR

## SHUTDOWN SOLENOID TEST

### **⚠ WARNING**

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### TEST DESCRIPTION

This test will determine if the shutdown solenoid is capable of functioning when it is energized with 12VDC.

### MATERIALS NEEDED

External 12VDC supply ( 30 amps required)  
Wiring Diagram  
Volt/Ohmmeter

This procedure takes approximately 40 minutes to perform.

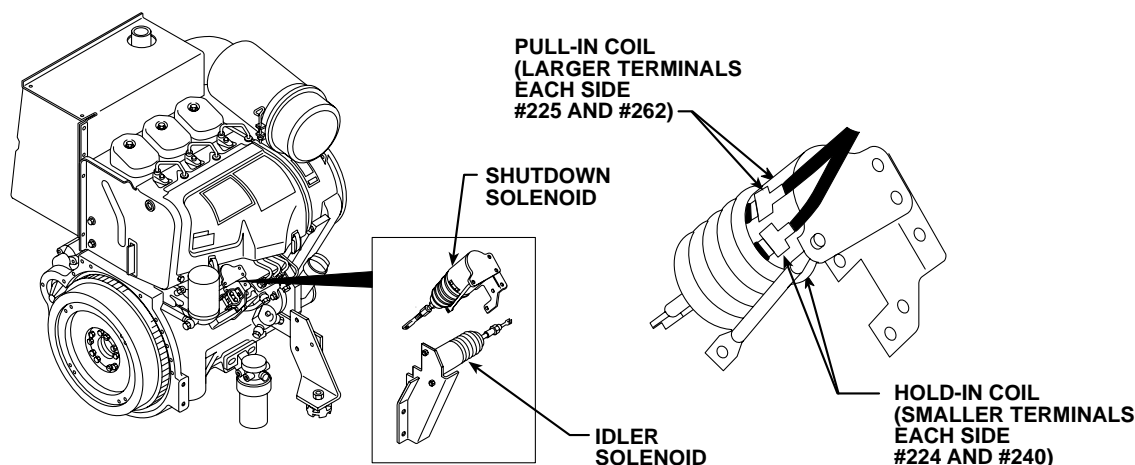
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# TROUBLESHOOTING & REPAIR

## SHUTDOWN SOLENOID TEST *(continued)*

FIGURE F.9 - SHUTDOWN SOLENOID LEAD TERMINALS



### TEST PROCEDURE

1. Turn the engine off.
2. Unlatch, lift and secure the right side engine service access door. Using a 5/16" nut driver, open up the control panel and tilt out. Remove the control board cover
3. Check the pull-in coil resistance by disconnecting lead #262 from the B2 terminal at the control board and measuring the resistance from lead #262 to the ground screw at the control board. Normal coil resistance is approximately 0.4 ohms. Reconnect lead #262 to the B2 terminal at the control board.

Check the hold-in coil resistance by disconnecting J3 & J4 from the control board and measuring across J3 pin 2 to J4 pin 5. Normal coil resistance is approximately 20 ohms. Reconnect J3 at the control board.

If either coil resistance is incorrect, the wiring may be faulty. Inspect the solenoid leads for faulty or loose connections.

If the lead connections are OK, recheck the coil resistances directly across the solenoid. If the coil resistances are incorrect, the solenoid may be faulty. Replace.

4. Using the external 12VDC voltage supply, apply 12VDC to the larger shutdown solenoid terminals (#262+ to #225-). The solenoid should activate.

### CAUTION

When the solenoid activates, remove the voltage supply immediately. Do not leave the external supply connected to terminals #262 and #225 for longer than three seconds. Component damage could result.

The solenoid should deactivate when the 12VDC supply is removed.

5. If the solenoid does not operate properly, check for a mechanical restriction in the linkage.
6. Using the external 12VDC voltage supply, apply 12VDC to the smaller solenoid terminals for the hold-in coil, (#240+ to #224-). Push in the solenoid plunger. With 12VDC applied to the hold-in coil, the plunger should stay in until the 12VDC is removed.
7. If the linkage is intact and the solenoid does not operate correctly when 12VDC is applied, the solenoid may be faulty. Replace.
8. Replace the harness leads to the correct terminals. See Figure F.9 and the Wiring Diagram. Replace any previously removed wire wraps.
- 8a. Using the control PC board layout, locate the Q25 on the control board. Scrape the environmental coating from all three legs of the device, and check the resistance between all three legs. If there is continuity between any of the legs, Q23 is bad. Replace the control PC board.
9. Close and secure the right side engine service access door. Replace the control board cover and close the control panel.

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# TROUBLESHOOTING & REPAIR

## ENGINE THROTTLE ADJUSTMENT TEST

### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### TEST DESCRIPTION

If the machine output is low or high, this test will determine whether the engine is operating at the correct speed (RPM) during both HIGH and LOW idle conditions. Directions for adjusting the throttle to the correct RPM are given.

### MATERIALS NEEDED

- Slot head screw driver
- 7/16" wrench
- 10mm wrench
- White or red marking pencil
- Strobe-tach, frequency counter, or oscilloscope
- 3/8" wrench

This procedure takes approximately 25 minutes to perform.

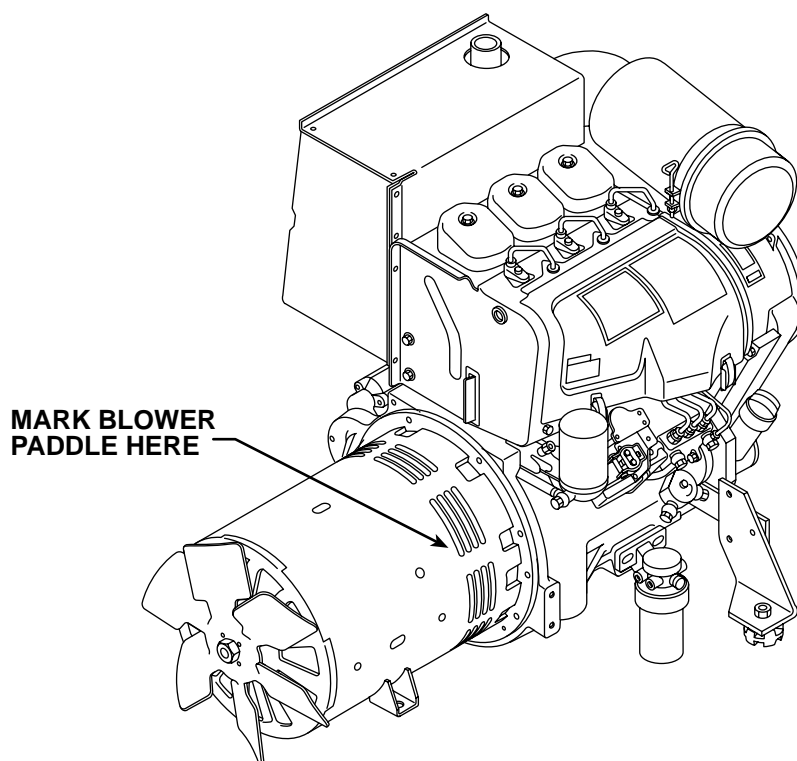
COMMANDER 400





## ENGINE THROTTLE ADJUSTMENT TEST *(continued)*

FIGURE F.10 - BLOWER PADDLE MARKED FOR STROBE-TACH METHOD



### TEST PROCEDURE

#### Strobe Tach Method

1. Conduct this procedure with the engine OFF.
2. Unlatch, lift and secure the right side engine service access door. Perform **Case Cover Removal and Replacement Procedure** through Step 11. (For Strobe-Tach method only.)
3. With a white or red marking pencil, place a mark on one of the blower paddles. See Figure F.10 for location.
4. Connect the strobe-tach according to the manufacturer's instructions.
5. Start the engine and direct the strobe-tach light on the blower paddle. Synchronize it to the rotating mark.

With the machine at HIGH IDLE the tach should read between 1890 and 1915 RPM.

With the machine at LOW IDLE the tach should read between 1325 and 1400 RPM.

## ENGINE THROTTLE ADJUSTMENT TEST *(continued)*

6. If either of the readings is incorrect, adjust the throttle as follows:

Adjust HIGH IDLE: Use the 10mm wrench to loosen the locking nut. See **Figure F.11** for location of the adjusting screw and locking nut. Turn the threaded screw counter-clockwise to increase the HIGH IDLE speed. Adjust the speed until the tach reads between 1890 and 1915 RPM. Retighten the locking nut.

Adjust LOW IDLE: First make sure there is no load on the machine. Set the IDLE switch to AUTO and wait for the engine to change to low idle speed. Use the 7/16" wrench to loosen the solenoid lever arm locking nut. See **Figure F.12**. Adjust the collar, to change the amount of throw in the lever arm, until the tach reads between 1325 and 1400 RPM. Retighten the locking nut.

### Frequency Counter Method

1. Plug the frequency counter into one of the 115 VAC auxiliary receptacles.
2. Start the engine and check the frequency counter. At HIGH IDLE (1900 RPM), the counter should read 63 Hz. At LOW IDLE (1400 RPM), the counter should read 47 Hz. Note that these are median measurements; hertz readings may vary slightly above or below.
3. If either of the readings is incorrect, adjust the throttle as follows:

Adjust HIGH IDLE: Use the 10mm wrench to loosen the locking nut. See **Figure F.11** for location of the adjusting screw and locking nut. Turn the threaded screw counter-clockwise to increase the HIGH IDLE speed. Adjust the speed until the frequency reads 63 Hz. Retighten the locking nut.

Adjust LOW IDLE: First make sure there is no load on the machine. Set the IDLE switch to AUTO and wait for the engine to change to low idle speed. Use the 7/16" wrench to loosen the solenoid lever arm locking nut. See **Figure F.12**. Adjust the collar, to change the amount of throw in the lever arm, until the frequency reads 47 Hz. Retighten the locking nut.

### Oscilloscope Method

1. Connect the oscilloscope to the 115 VAC receptacle, according to the manufacturer's instructions. At HIGH IDLE (1900 RPM), the waveform should exhibit a period of 15.8 milliseconds. At 1400 RPM, the waveform should exhibit a period of 21.4 milliseconds. Refer to the **NORMAL OPEN CIRCUIT VOLTAGE WAVEFORM (115 VAC AUXILIARY) HIGH IDLE - NO LOAD** in this section of the manual.
2. If either waveform periods is incorrect, adjust the throttle as follows:

Adjust HIGH IDLE: Use the 10mm wrench to loosen the locking nut. See **Figure F.11** for location of the adjusting screw and locking nut. Turn the threaded screw counter-clockwise to increase the HIGH IDLE speed. Adjust the speed until the period is 15.8 milliseconds. Retighten the locking nut.

Adjust LOW IDLE: First make sure there is no load on the machine. Set the IDLE switch to AUTO and wait for the engine to change to low idle speed. Use the 7/16" wrench to loosen the solenoid lever arm locking nut. See **Figure F.12**. Adjust the collar, to change the amount of throw in the lever arm, until the period is 21.4 milliseconds. Retighten the locking nut.

# TROUBLESHOOTING & REPAIR

## ENGINE THROTTLE ADJUSTMENT TEST *(continued)*

FIGURE F.11 - HIGH IDLE ADJUSTMENT

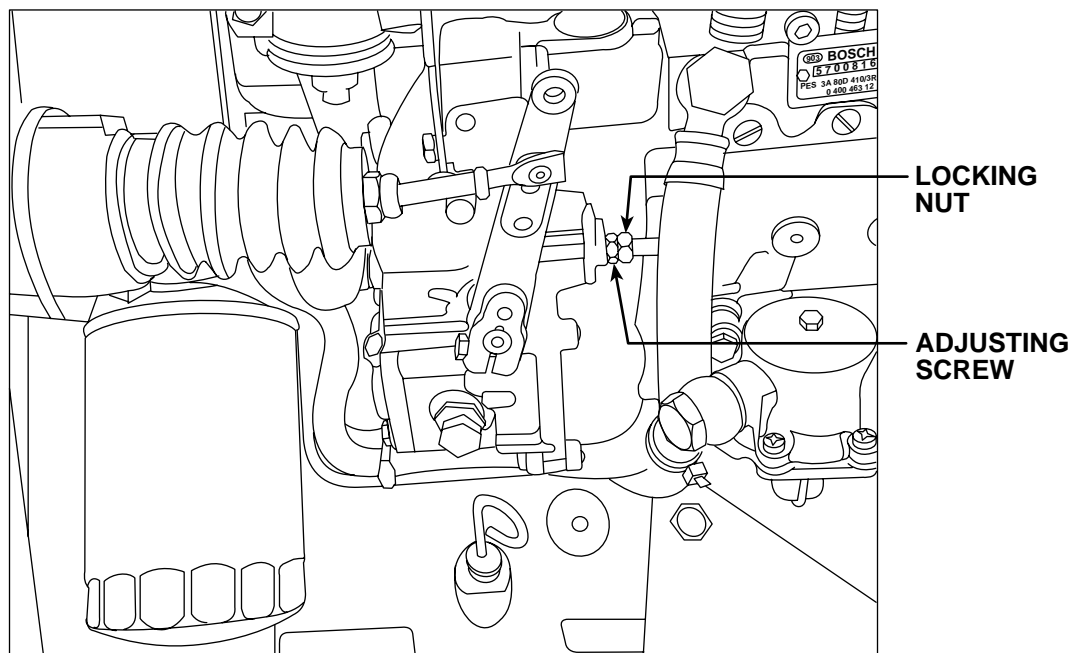
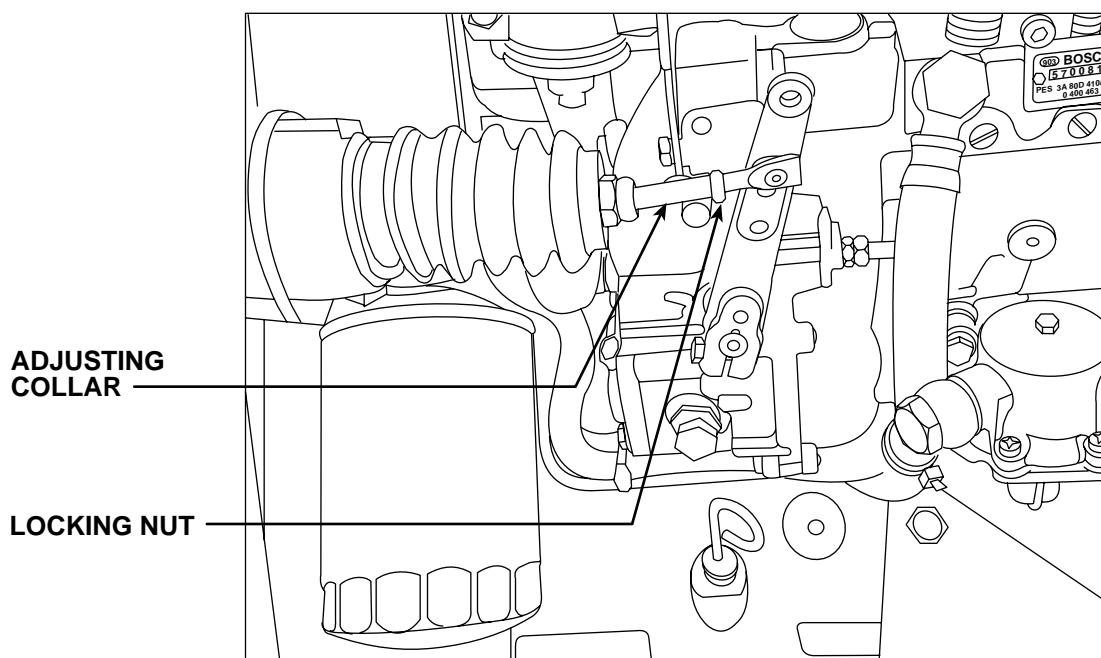


FIGURE F.12 - LOW IDLE ADJUSTMENT



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# TROUBLESHOOTING & REPAIR

## STATIC SCR/DIODE RECTIFIER BRIDGE TEST

### **⚠ WARNING**

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

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### TEST DESCRIPTION

This test will help determine if an SCR or diode is shorted or "leaky." See the Oscilloscope Waveforms in this section for normal output waveforms.

### MATERIALS NEEDED

- Analog Volt/Ohmmeter (Multimeter)
- 5/16" Nut driver
- 3/8" Nut driver
- Commander 400 Wiring Diagrams (See the Electrical Diagrams section of this manual.)

This procedure takes approximately 65 minutes to perform.

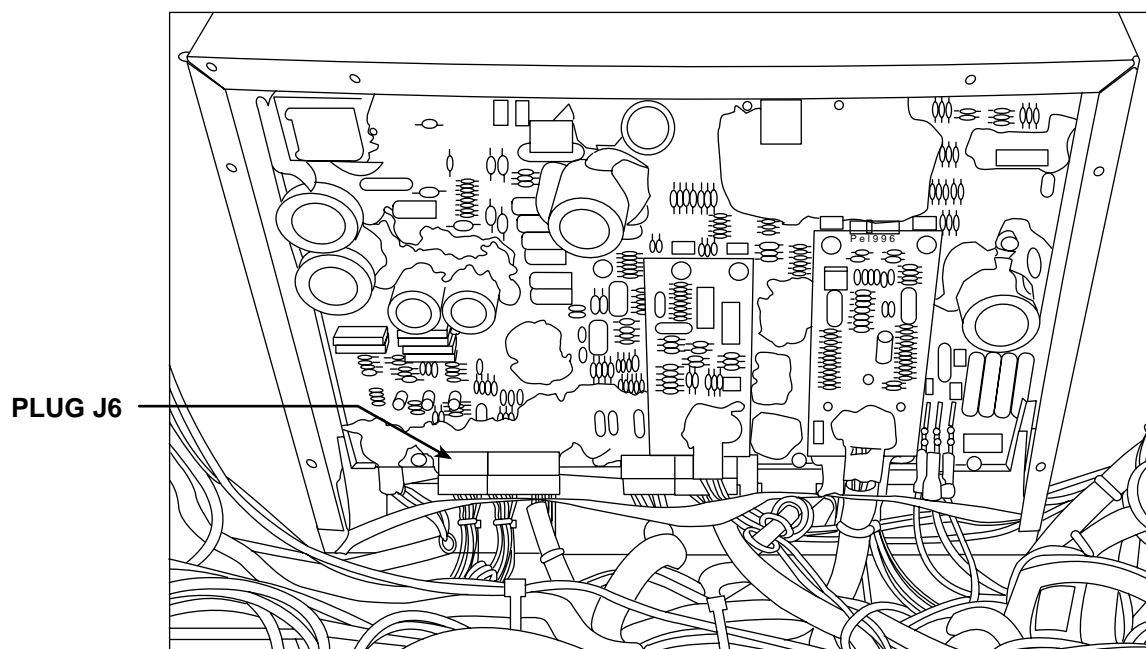
COMMANDER 400



# TROUBLESHOOTING & REPAIR

## STATIC SCR/DIODE RECTIFIER BRIDGE TEST *(continued)*

FIGURE F.13 – CONTROL BOARD PLUG J6 LOCATION



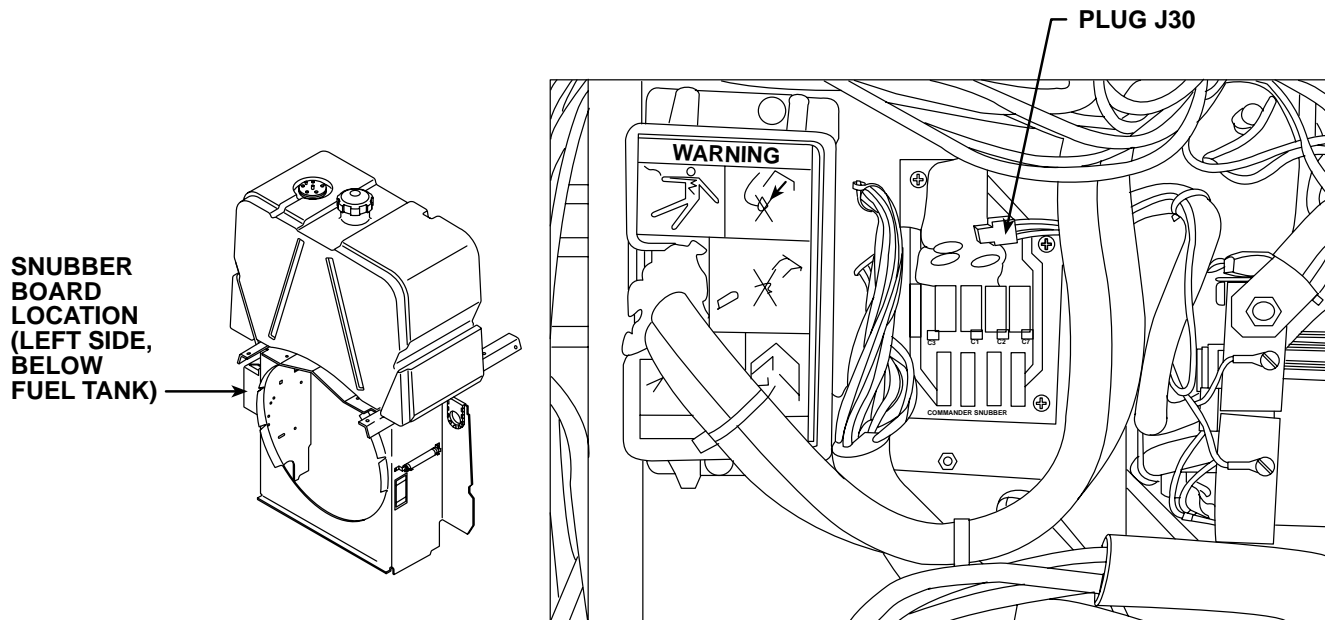
### TEST PROCEDURE

1. Turn off the engine.
2. Disconnect the welding cables from the welding output terminals.
3. Perform the **Case Removal Procedure** (including front shroud removal).
4. Using the 5/16" nut driver, remove the control board cover. See Figure F.13.
5. Locate and remove molex plug J6 from the control board. See Figure F.13.

# TROUBLESHOOTING & REPAIR

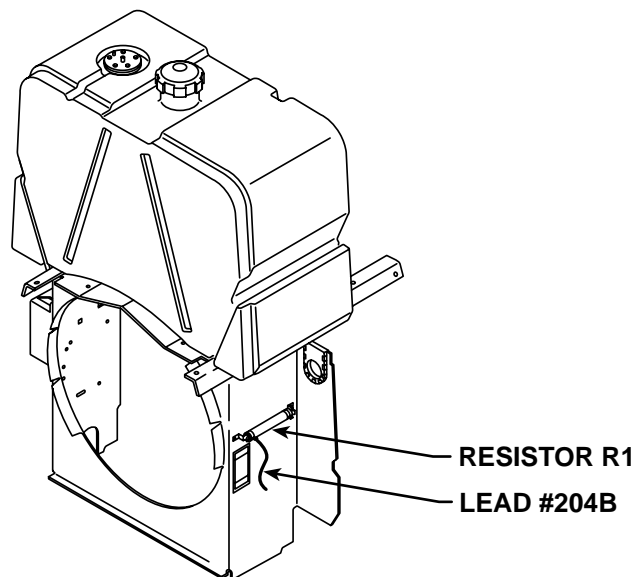
## STATIC SCR/DIODE RECTIFIER BRIDGE TEST *(continued)*

FIGURE F.14 – SNUBBER BOARD PLUG J30 LOCATION



6. Using the 3/8" nut driver, locate and remove the snubber board cover. See Figure F.14.
7. Locate and remove molex plug J30 from the snubber board. See Figure F.14.
8. Locate and remove lead #204B from resistor R1 (50 ohms, 100 Watts). See Figure F.15.

FIGURE F.15 – RESISTOR R1 LOCATION

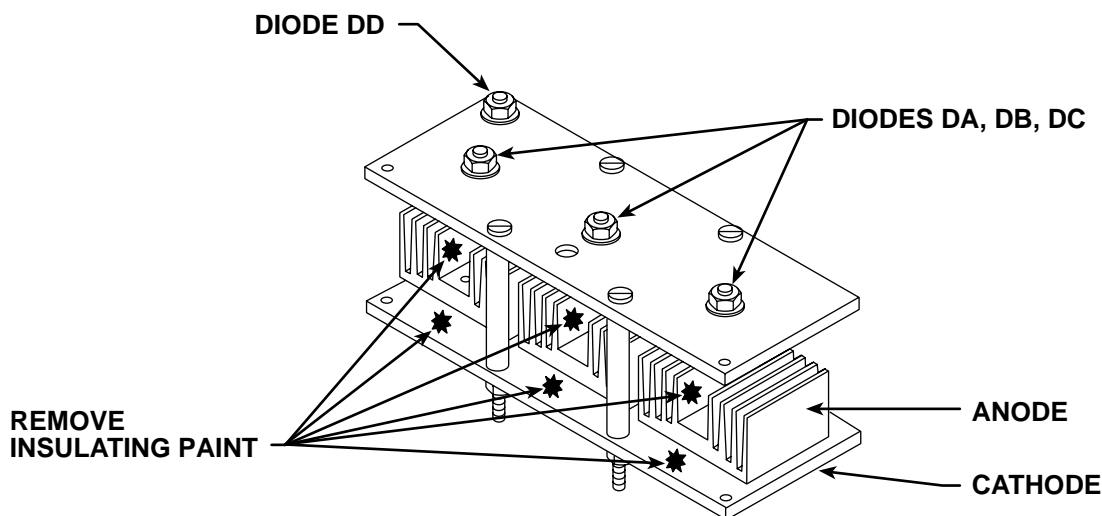


COMMANDER 400

# TROUBLESHOOTING & REPAIR

## STATIC SCR/DIODE RECTIFIER BRIDGE TEST *(continued)*

FIGURE F.16 – HEAT SINK AND SCR TEST POINTS



9. Remove the red insulating paint from the heat sink test points. See Figure F.16.

**NOTE:** Do not disassemble the heat sink.

10. Measure the resistance from the anode to the cathode of SCR A, using an analog volt/ohmmeter (multimeter) set at R x 1000 scale. See Figure F.16.

- a. Reverse the meter leads and measure the resistance from the cathode to the anode of SCR A. See Figure F.16.
- b. If a low resistance is measured in either meter polarity, SCR A is faulty. Replace SCR A.

11. Test the resistance of SCR B and SCR C using the same procedure described in Step 10.

12. Measure the resistance of diode DD from anode (+probe) to cathode (-probe) using an analog ohmmeter set at R x 1000 scale. The resistance should be low. See Figure F.16.

- a. Reverse the meter leads and measure the resistance from cathode (+probe) to anode (-probe) of diode DD. The resistance should be high. See Figure F.16.

- b. If a low resistance is measured in both meter polarities, diode DD is shorted. Replace diode DD.

- c. If a high resistance is measured in both meter polarities, diode DD is open. Replace diode DD.

13. Test diodes DA, DB and DC for proper operation using the same procedure described in Step 12.

14. Reconnect all leads and molex plugs.

15. If this test did not identify the problem or to further test the SCRs, go to the **Active SCR Test**.

If the test is complete, connect plug J6 to the control board and plug J30 to the snubber board and reconnect lead #204B to resistor R1. Replace the covers to the two boards. Replace all case covers. (See the **Case Cover Removal and Replacement** procedure.)



# TROUBLESHOOTING & REPAIR

## ACTIVE SCR TEST

### **⚠ WARNING**

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### TEST DESCRIPTION

This test will help determine if the device can be gated ON and conduct current from anode to cathode.

### MATERIALS NEEDED

An SCR tester as specified in this procedure.

5/16" nut driver

3/8" nut driver

Commander 400 Wiring Diagrams (See the Electrical Diagrams section of this manual.)

This procedure takes approximately 60 minutes to perform.

COMMANDER 400

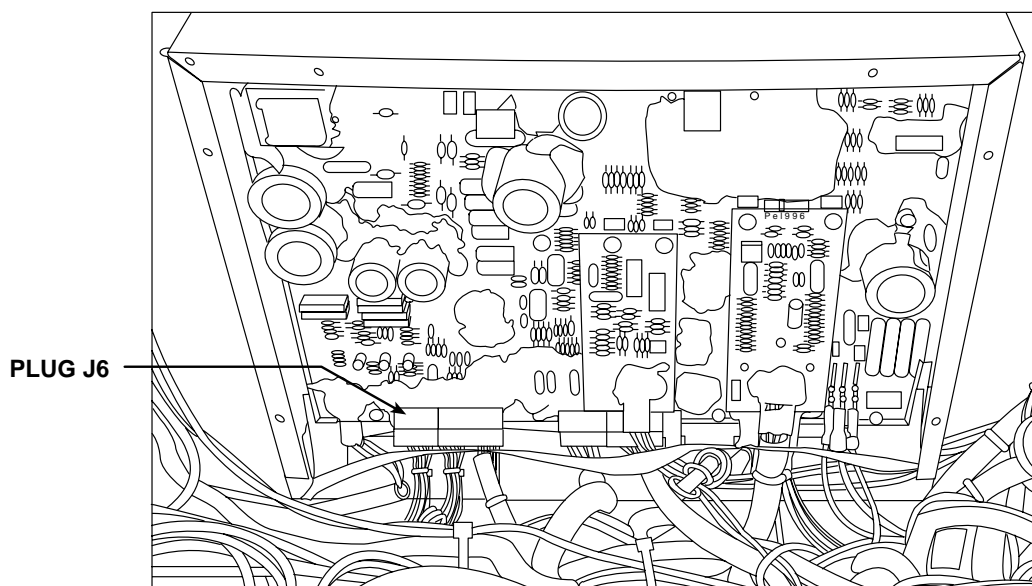


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# TROUBLESHOOTING & REPAIR

## ACTIVE SCR TEST (continued)

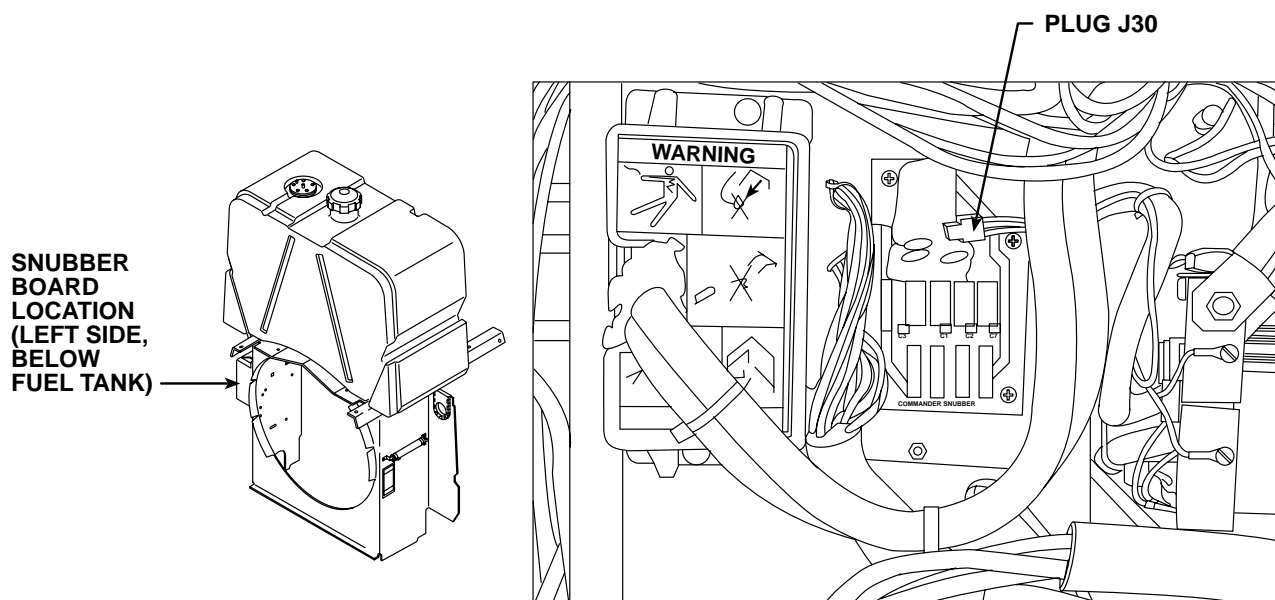
FIGURE F.17 – CONTROL BOARD PLUG J6 LOCATION



## TEST PROCEDURE

1. Turn OFF the engine.
2. Perform the **Case Removal** procedure (including front shroud removal).
3. Disconnect the welding cables from the welding output terminals.
4. Using the 5/16" nut driver, remove the control board cover. See Figure F.17.
5. Locate and remove molex plug J6 from the control board. See Figure F.17.
6. Using the 3/8" nut driver, locate and remove the snubber board cover. See Figure 18.
7. Locate and remove molex plug J30 from the snubber board. See Figure F.18.

FIGURE F.18 – SNUBBER BOARD PLUG J30 LOCATION

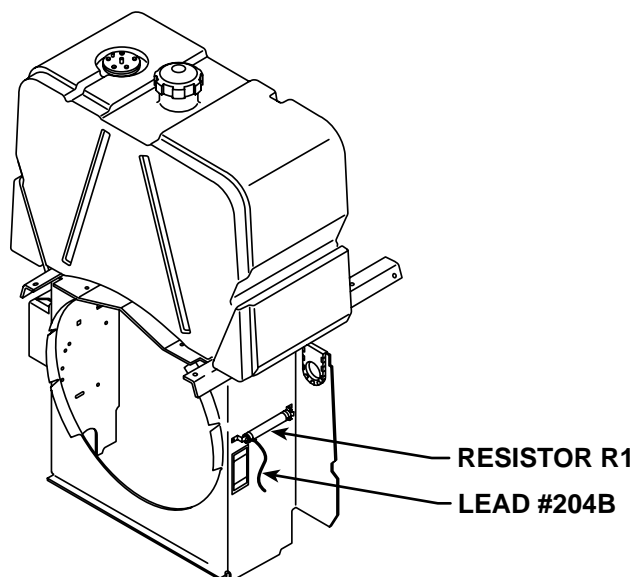


COMMANDER 400

# TROUBLESHOOTING & REPAIR

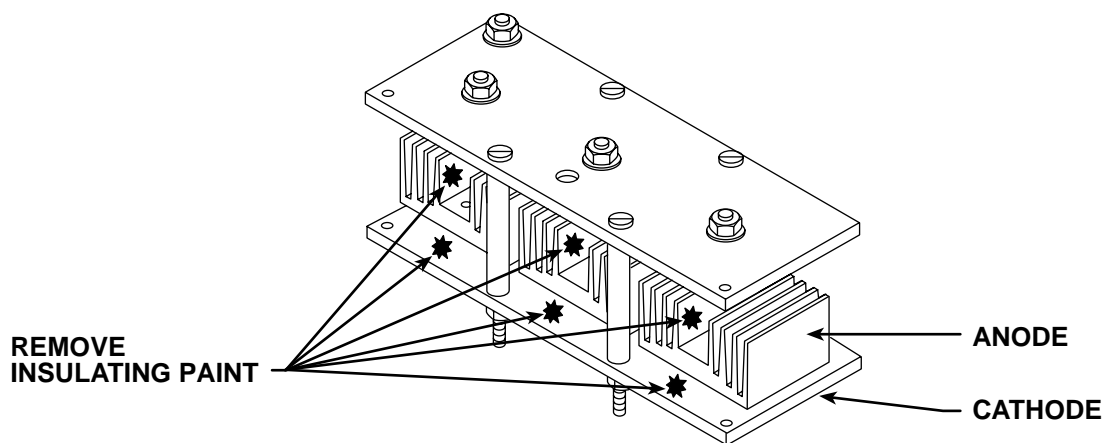
## ACTIVE SCR TEST (continued)

FIGURE F.19 - RESISTOR R1 LOCATION



8. Locate and remove lead #204B from resistor R1 (50 ohms, 100 Watts). See Figure F.19.

FIGURE F.20 - HEAT SINK TEST POINTS



9. Remove the red insulating paint from the heat sink test points. See Figure F.20.

**NOTE:** Do not disassemble the heat sinks.

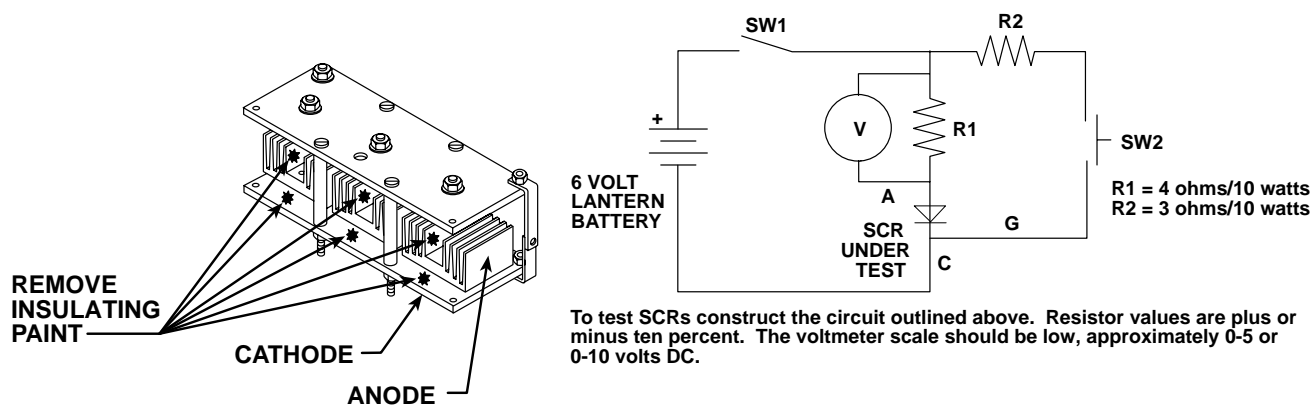
COMMANDER 400



## TROUBLESHOOTING &amp; REPAIR

ACTIVE SCR TEST (*continued*)

FIGURE F.21 - SCR TESTER CIRCUIT AND SCR CONNECTIONS



10. Construct the circuit shown in Figure F.21. One 6-volt lantern battery can be used. Set voltmeter scale low, at approximately 0-5 volts or 0-10 volts.
  11. Test the voltage level of the battery. Short leads (A) and (C). Close switch SW-1. Battery voltage should be 4.5 volts or higher. If lower, replace the battery.
  12. Connect the tester to the SCR A as shown in Figure F.21.
    - a. Connect tester lead (A) to the anode.
    - b. Connect tester lead (C) to the cathode.
    - c. Connect tester lead (G) to the gate.
  13. Close switch SW-1.
- NOTE:** Switch SW-2 should be open.
14. Read meter for zero voltage.
    - a. If the voltage reading is higher than zero, the SCR is shorted.
  15. Close or keep closed switch SW-1.
  16. Close switch SW-2 for 2 seconds. Release and read meter.
    - a. If the voltage is 3-6 volts while the switch is closed and after the switch is open, the SCR is functioning.
    - b. If the voltage is 3-6 volts only when the switch is closed or if there is no voltage when the switch is closed, the SCR is defective.
- NOTE:** Be sure the battery is functioning properly. A low battery can affect the results of the test. Repeat Battery Test Procedure in Step 11 if needed.
17. Open switch SW-1.
  18. Reconnect the tester leads. See Figure F.21.
    - a. Connect tester lead (A) to the cathode.
    - b. Connect tester lead (C) to the anode.
    - c. Disconnect test lead (G) from the gate.
  19. Close switch SW-1.
  20. Read meter for zero voltage.
    - a. If the voltage is zero, the SCR is functioning.
    - b. If the voltage is higher than zero, the SCR is shorted.
  21. Perform the Active Test Procedure outlined in Steps 12-20 for SCRs B and C.
  22. Replace all SCR assemblies that do not pass the above tests.
  23. Replace all molex plugs onto the control board and snubber board. Reconnect lead #204B resistor R1.
  24. Replace the snubber board cover and control board cover.
  25. Replace all case covers. (See the **Case Cover Removal and Replacement** procedure.)

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## CHARGING CIRCUIT TEST

### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### TEST DESCRIPTION

This test will determine if the engine alternator and associated circuitry are functioning properly.

### MATERIALS NEEDED

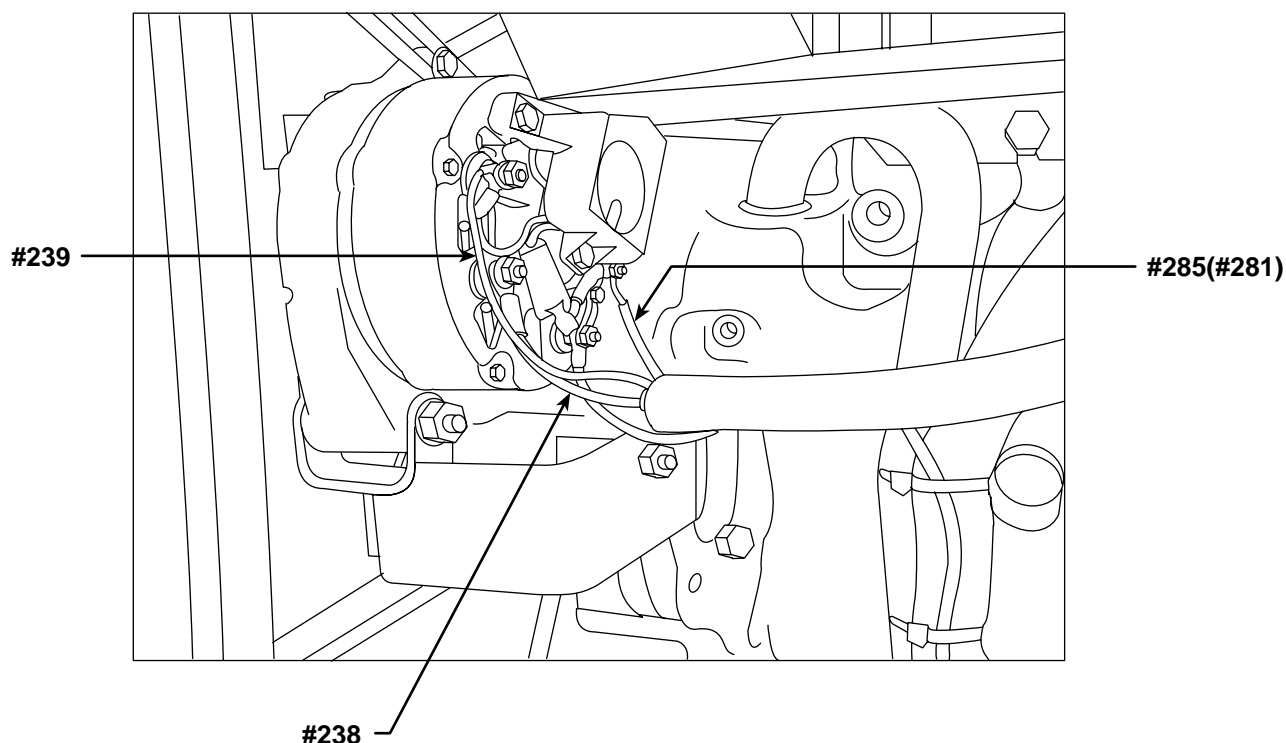
Volt/Ohmmeter  
5/16" Nut driver  
3/8" Nut driver  
Wiring Diagram

This procedure takes approximately 25 minutes to perform.

# TROUBLESHOOTING & REPAIR

## CHARGING CIRCUIT TEST (*continued*)

FIGURE F.22 – ENGINE ALTERNATOR LOCATION



### TEST PROCEDURE

1. Turn the engine off.
2. Perform the **Case Cover Removal Procedure** up to Step 7.
3. Locate the engine alternator. See Figure F.22.
4. Start the engine and run it at high idle (1900 RPM).
5. Set the voltmeter for DC volts and measure the DC volts at lead #239 to engine ground. See the Wiring Diagram. Normal is 12.5 to 14.5VDC.
6. Set the voltmeter for DC volts and measure the DC volts at lead #238 to engine ground. See the Wiring Diagram. Normal is 12.5 to 14.5VDC.
7. Set the voltmeter for DC volts and measure the DC volts at lead #285 to engine ground. See the Wiring Diagram. Normal is 12.5 to 14.5 VDC.
8. If the correct flashing voltage is present and the charging output voltage is low or missing, the engine alternator may be faulty.
9. Stop the engine and check alternator V-belt for proper tension. See the engine operation manual.
10. Replace all case covers that were removed. (See the **Case Cover Removal Procedure**.)

**NOTE:** Some earlier machines may have a lead #281 instead of #285. Lead #285 carries the flashing voltage for the engine alternator. Battery voltage should be present whenever the engine is running. See the Wiring Diagram. On the earlier machines, lead #281 carries the flashing voltage for the engine alternator. Battery voltage should be present whenever the start button (S2) is pushed. See the Wiring Diagram.

# TROUBLESHOOTING & REPAIR

## STATOR VOLTAGE TEST

### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### TEST DESCRIPTION

This test will determine if the correct AC voltages are being generated from the stator windings.

### MATERIALS NEEDED

Volt/Ohmmeter  
3/8" Nut driver  
Wiring Diagram  
7/16" Wrench

This procedure takes approximately 55 minutes to perform.

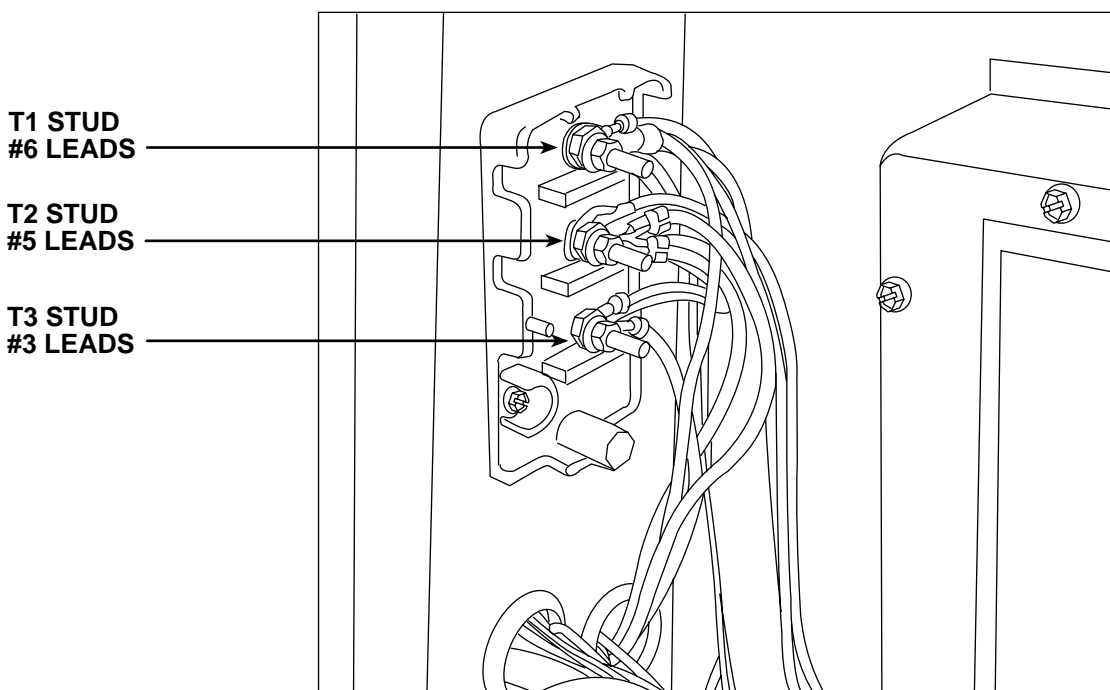
COMMANDER 400



# TROUBLESHOOTING & REPAIR

## STATOR VOLTAGE TEST *(continued)*

FIGURE F.23 – CONTROL BOX STUD TERMINALS



### TEST PROCEDURE – Auxiliary Power Windings Test

1. Turn off the engine.
2. Perform the **Case Cover Removal Procedure**, including front shroud removal. For this test the control box cover will be open.
3. Start the engine and run at high idle (1900 RPM). Do NOT load welding or auxiliary power.
4. Check for 115 - 132VAC at leads 5A to 3B located at the stud terminals inside the control box. See the Wiring Diagram and Figure F.23.
5. Check for 230 - 250VAC at leads 6A to 3A at the stud terminals inside the control box. See the Wiring Diagram and Figure F.23.

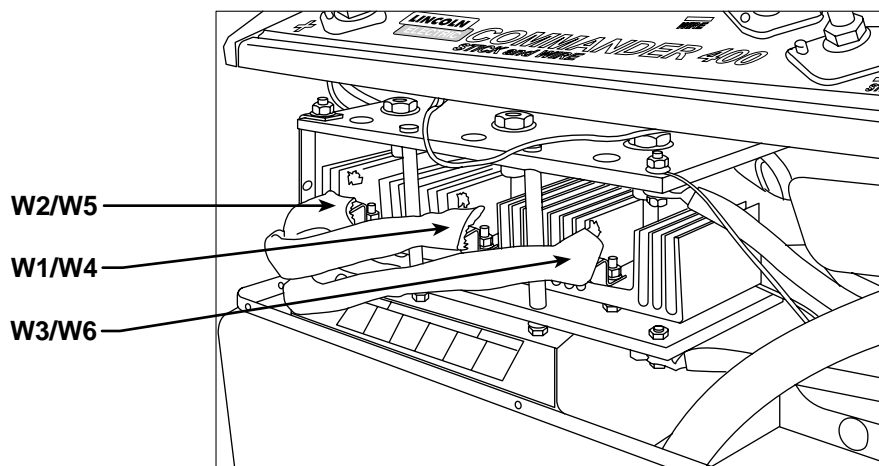
If any of the above voltage checks are low or missing, check the associated leads for loose or faulty connections. See the Wiring Diagram. Then proceed to the Exciter **Winding Voltage Test**.



# TROUBLESHOOTING & REPAIR

## STATOR VOLTAGE TEST (continued)

FIGURE F.24 – SCR/DIODE RECTIFIER BRIDGE LEADS

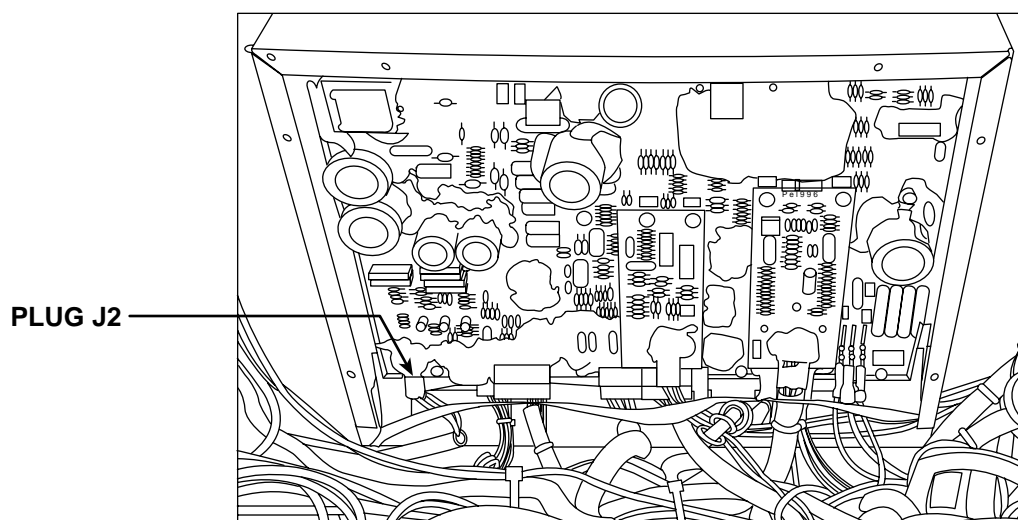


### TEST PROCEDURE – Weld and PC Board Windings Test

7. Check for 48-55VAC at leads W1/W4 to leads W2/W5 located at the SCR/Diode Bridge. See Figure F.24 and the Wiring Diagram.
8. Check for 48 - 55VAC at leads W2/W5 to leads W3/W6 located at the SCR/Diode Bridge. See Figure F.24 and the Wiring Diagram.
9. Check for 48 - 55VAC at leads W3/W6 to leads W1/W4 located at the SCR/Diode Bridge. See Figure F.24 and the Wiring Diagram.
10. Check for approximately 42VAC at leads E1 to E2 located at plug J2 on the control board. See Figure F.25. Do not remove the plug from the control board.

If any of the above voltage checks are low or missing, check the associated leads for loose or faulty connections. See the Wiring Diagram. Then proceed to the **Exciter Winding Voltage Test**

FIGURE F.25 – CONTROL BOARD PLUG J2 LOCATION



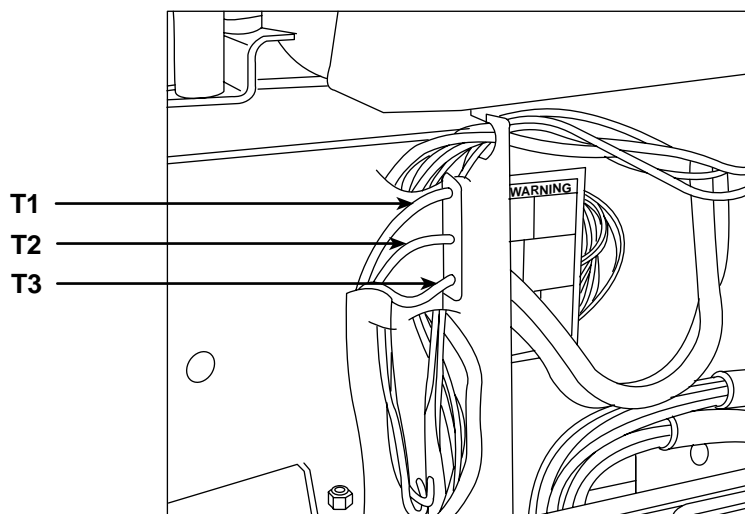
COMMANDER 400



# TROUBLESHOOTING & REPAIR

## STATOR VOLTAGE TEST (*continued*)

FIGURE F.26 – EXCITER LEADS T1, T2, T3



### TEST PROCEDURE – Exciter Winding Voltage Test

11. Turn the engine off.
12. Locate the exciter leads T1, T2 and T3. See Figure F.26.
13. Carefully pierce the insulation on leads T1, T2 and T3 for voltage measurements.

#### **⚠ CAUTION**

Make the smallest possible puncture away from any sheet metal parts. Reinsulate these punctures at the end of this test.

14. Start the engine and run it at high idle (1900 RPM).

15. Using the voltmeter **carefully** check for 460 - 550VAC from T1 to T2.
16. Using the voltmeter **carefully** check for 460 - 550VAC from T2 to T3.
17. Using the voltmeter **carefully** check for 460 - 550VAC from T3 to T1.

If the Exciter Winding Voltage Test is OK and any of the other voltage checks are low or missing, the stator may be faulty. Check for "shorted" or "grounded" windings in the stator.

If the exciter voltages are low or missing, the capacitors or associated leads may be faulty. Check for grounded or shorted windings. See the Wiring Diagram.

18. Replace the front shroud and all case covers that were removed. (See the **Case Cover Removal Procedure**.)

# TROUBLESHOOTING & REPAIR

## FINE CONTROL POTENTIOMETER TEST



### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

This test will determine whether the fine control potentiometer and PC board are defective. Failure or intermediate failure of the control potentiometer circuit can result in erratic weld output or loss of weld output.

### MATERIALS NEEDED

5/16" Nut Driver

Multi-Meter

Commander 400 Wiring Diagram (See the electrical diagrams section of this manual)

Control PC Board Layout (See the electrical diagrams section of this manual)

This procedure takes approximately 25 minutes to perform.

COMMANDER 400



# TROUBLESHOOTING AND REPAIR

## FINE CONTROL POTENTIOMETER TEST *(continued)*

### TEST PROCEDURE

**NOTE:** In this test procedure, the positive output stud is used for common.

1. Using the 5/16" nut driver, open the control panel and tilt out. Remove the control board cover. Put the LOCAL/REMOTE switch in the "LOCAL" position. Set the range switch to the general fabrication tap. Start the machine.



### WARNING



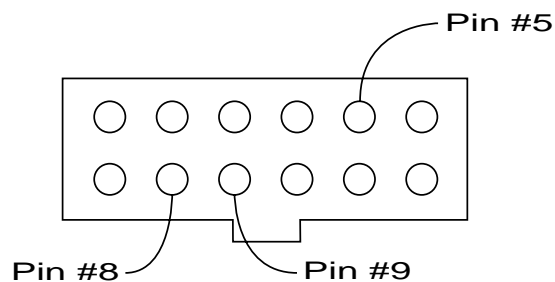
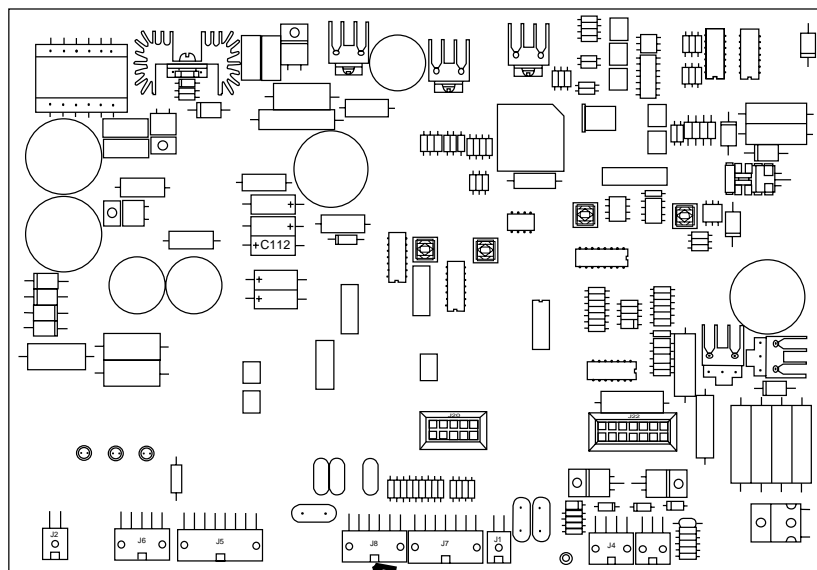
There are high voltages present inside the control box while the machine is running. **THE VOLTAGES ARE HIGH ENOUGH TO KILL.** Use extreme caution to avoid the back-side of the receptacles, breakers, and terminal strip while checking voltages inside the control box.

2. With the control potentiometer in the minimum position, check the voltage at the control board from J8 pin 8 to common. Voltage should be approximately -.025 VDC.
3. Slowly turn the control potentiometer CW. The voltage should steadily increase from approximately -.025 VDC in the minimum position to

approximately 5.00 VDC in the maximum position. Also, the display on the control panel should steadily increase from 50-575.

4. If step 2 or 3 fails, turn off the machine. At J8 pins 5, 8, & 9, perform a resistance check of the fine control potentiometer (the control potentiometer is a 10K ohm potentiometer). See Figure F.27. Also, check continuity of all fine control potentiometer leads and LOCAL/REMOTE switch. If any of the leads, switch or potentiometer fails the resistance check, replace the faulty component.
5. If the leads, switch and potentiometer pass the resistance check, disconnect the J8 from the control board and start the machine. Check the voltage from J8 pin 9 to common. The voltage should be approximately 5.11 VDC. Check the voltage from J8 pin 5 to common. The voltage should be approximately -.049 VDC. If either voltage check fails, replace the PC board.
6. Repeat steps 2-4 with the LOCAL/REMOTE switch in the "REMOTE" position and a remote control potentiometer hooked up to either amphenol. When doing any continuity checks, be sure to include the RF bypass PC board and associated leads.
7. When the test is complete, replace the control board cover and close the control panel.

**Figure F.27 Control Board Plug J8 location**



**Plug J8**

COMMANDER 400



TROUBLESHOOTING & REPAIR

RANGE SWITCH TEST



WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

DESCRIPTION

This test will determine whether the range switch is defective. Failure or intermittent failure of the range switch can cause erratic weld output.

MATERIALS NEEDED

- 5/16" Nut Driver
- Multi-Meter
- Commander 400 Wiring Diagram (See the electrical diagrams section of this manual)
- Control PC Board Layout (See the electrical diagrams section of this manual)

This procedure takes approximately 30 minutes to perform.

TROUBLESHOOTING AND REPAIR

RANGE SWITCH TEST (continued)

TEST PROCEDURE

**NOTE:** In this test procedure, the positive output stud is used for common.

1. Using the 5/16" nut driver, open the control panel and tilt out. Remove the control board cover. Start the machine.



**WARNING**



There are high voltages present inside the control box while the machine is running. **THE VOLTAGES ARE HIGH ENOUGH TO KILL.** Use extreme caution to avoid the backside of the receptacles, breakers, and terminal strip while checking voltages inside the control box.

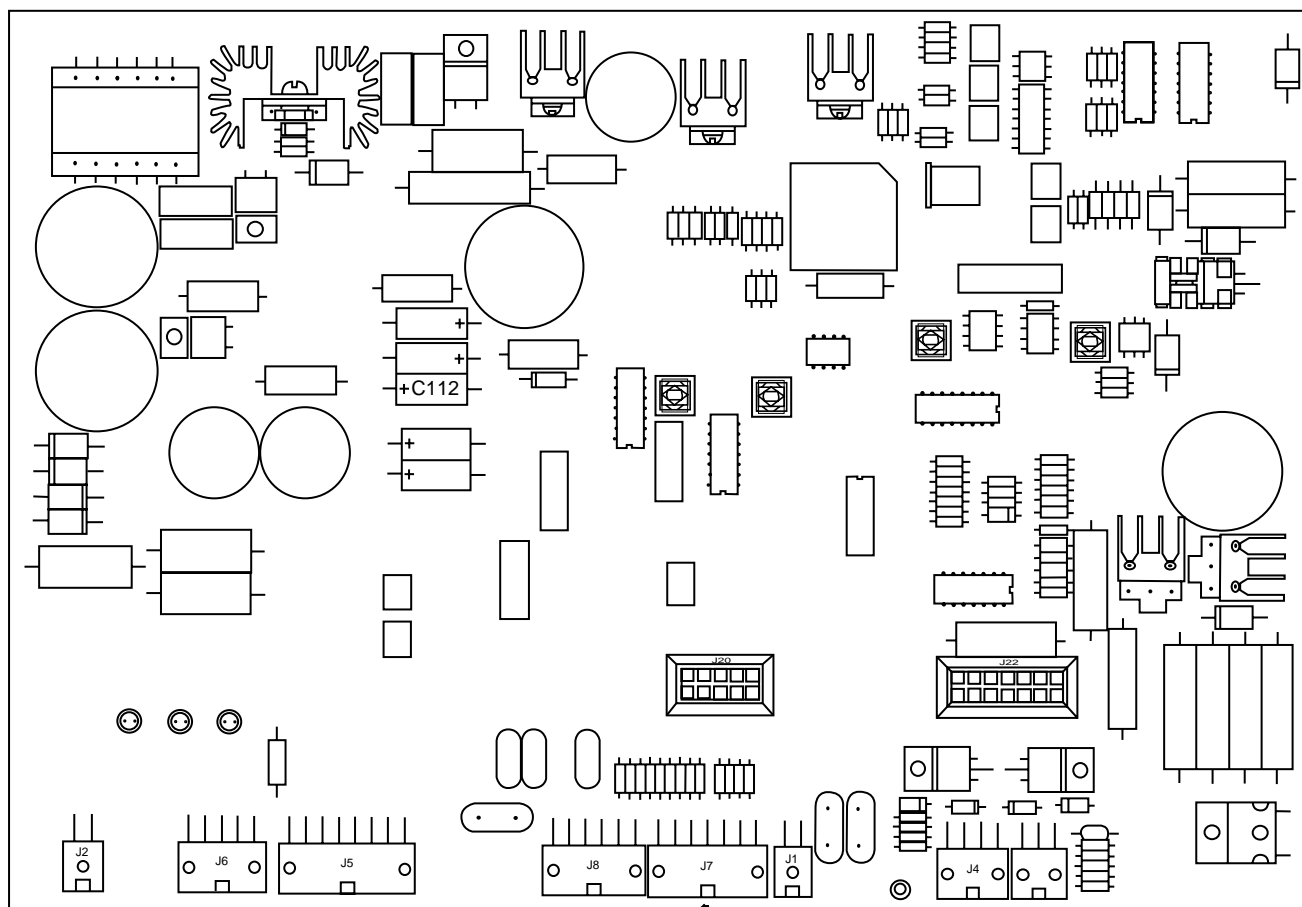
2. Put the range switch in the CV position on stick & wire machines, or in the 90 tap on stick only machines.  
3. Check the voltage at the control board from J7 pin 10 to common at each tap on the range switch. **See Figure F.28.** See table F.1 below for approximate voltage reading from each tap.  
4. If any of the voltages in the table are incorrect, replace the range switch.  
5. If the test is complete, replace the control board cover and close the control panel.

Table F.1

Range Switch Position	Voltage
CV tap	.580 Vdc (if so equipped)
90 tap	.937 Vdc
120 tap	1.29 Vdc
180 tap	1.65 Vdc
230 tap	2.00 Vdc
270 tap	2.36 Vdc
400 tap	2.69 Vdc
50-575 tap	3.06 Vdc

RANGE SWITCH TEST *(continued)*

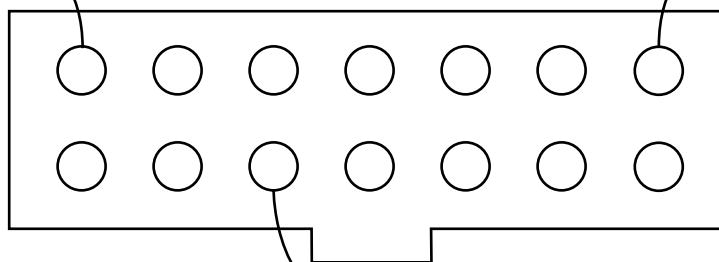
Figure F.28 Control Board Plug J7



Plug J7

Pin #1

Pin #7



Pin #10

COMMANDER 400

NOTES

Return to Section TOC	Return to Section TOC	Return to Section TOC	Return to Section TOC
Return to Master TOC	Return to Master TOC	Return to Master TOC	Return to Master TOC





# TROUBLESHOOTING & REPAIR

## SHUNT CALIBRATION TEST



### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

This test will determine whether the 600 amp shunt is out of calibration.

### MATERIALS NEEDED

5/16" Nut Driver

Multi-Meter

Resistive Grid Bank

Commander 400 Wiring Diagram (See the electrical diagrams section of this manual)

Control PC Board Layout (See the electrical diagrams section of this manual)

This procedure takes approximately 40 minutes to perform.

# TROUBLESHOOTING AND REPAIR

## SHUNT CALIBRATION TEST *(continued)*

### TEST PROCEDURE

**NOTE:** In this test procedure, the positive output stud is used for common.

1. Using the 5/16" nut driver, open the control panel and tilt out. Remove the control board cover. Start the machine.



### WARNING

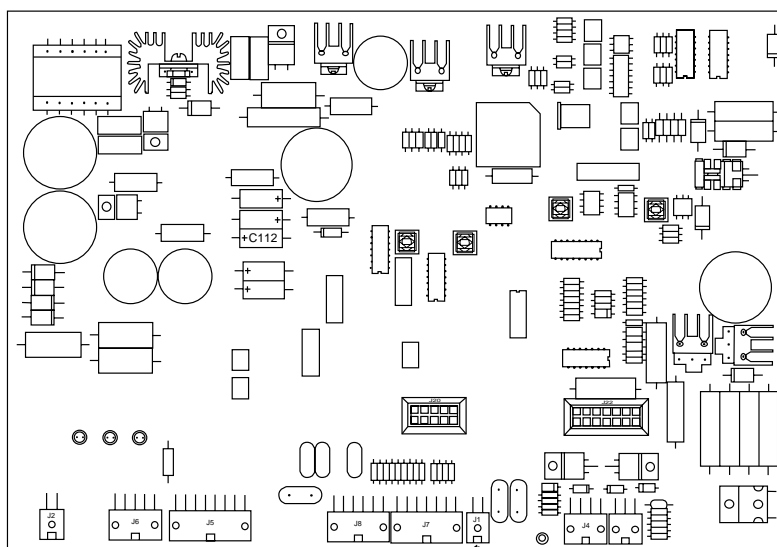


There are high voltages present inside the control box while the machine is running. **THE VOLTAGES ARE HIGH ENOUGH TO KILL.** Use extreme caution to avoid the back-side of the receptacles, breakers, and

terminal strip while checking voltages inside the control box.

2. Set the range switch to the CC/General fabrication tap. Using the fine control pot, set the pre-set amps on the display to 300 amps.
3. Using a grid bank, load the machine to 300 amps at 25 volts using an external ammeter and voltmeter.
4. At the control board, measure the voltage from J1 pin 3 (pos. lead) to J1 pin 2 (neg. lead). See Figure F.29. The voltage should be 25 mVDC +/- 5%. The current reading on the display should be within +/- 5% with the external ammeter. See Figure F.29.
5. If step 4 fails, the shunt is out of calibration and must be replaced.
6. If the test is complete, replace the control board cover and close the control panel.

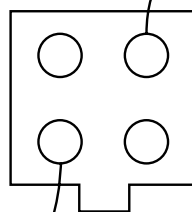
Figure F.29 Control Board Plug J1



Plug J1

-Pin #2

+Pin #3



COMMANDER 400



## TROUBLESHOOTING & REPAIR

### EXCITER VOLTAGE FEEDBACK TEST



#### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

#### DESCRIPTION

This test will determine whether the exciter voltage module is reading each exciter phase voltage back to the control board accurately. An inaccurate reading can cause the control board to shut down the machine with an "ECH" or "ECL" error code when operating the machine at high currents.

#### MATERIALS NEEDED

None

This procedure takes approximately 20 minutes to perform.

# TROUBLESHOOTING AND REPAIR

## EXCITER VOLTAGE FEEDBACK TEST *(continued)*

### TEST PROCEDURE

1. Set the machine to the following settings, then start the machine:  
Control dial to 1 (min)  
Range dial to 90A max  
Idler switch in the "Auto" position  
Output control source (2-4) switch in the "Welding Terminals Remotely Controlled" position.
2. As the unit powers up, the display will step thru its' initialization sequence. As soon as the display shows "---", the user must toggle the idler switch from "Auto" to "High" 5 times in 5 seconds. The display will read "tal", then "000". The idler switch must be returned to the "Auto" position. If the user misses toggling the Idler switch 5 times in 5 seconds, the machine will default to normal operation, and step 1 & 2 must be repeated.
3. Toggle the 2-4 switch to the "Welding Terminals Always On" position. The display will read the phase 1 no load exciter voltage. The voltage should be between 400-525 Vac. Return the 2-4 switch to the "Welding Terminals Remotely Controlled" position.
4. Toggle the Idler switch from "Auto" to "High", then back to "Auto". The display should read "001". Repeat step 3 to read the phase 2 no load exciter voltage.
5. Toggle the idler switch from "Auto" to "High", then back to "Auto". The display should read "002". Repeat step 3 to read the phase 3 no load exciter voltage.
6. For machines equipped with G2713-1 boards, toggle the Idler switch once from "Auto" to "High". The display should read "003". For machines equipped with G2713-2 & 3 boards, toggle the idler switch 3 times from "Auto" to "High" to "Auto" till the display reads "000" again.
7. Turn the control dial to 10 (max). Toggle the 2-4 switch to the "Welding Terminals Always On" position. Apply a grid load so that the machine's output is 565-585 amps at a minimum of 30 VDC. The display will read the phase 1 exciter voltage under load. Record the phase 1 exciter voltage under load. Return the 2-4 switch to the "Welding Terminals Remotely Controlled" position.
8. Toggle the Idler switch from "Auto" to "High", then back to "Auto". The display should read "001" (or "004" for machines equipped with G2713-1 board). Repeat step 7 to read the phase 2 exciter voltage under load.
9. Toggle the idler switch from "Auto" to "High", then back to "Auto". The display should read "002" (or "005" for machines equipped with G2713-1 board). Repeat step 7 to read the phase 3 exciter voltage under load.
10. If all exciter voltage readings on the display are correct, the exciter board is properly calibrated and the test is complete. If the average of the three exciter voltage readings under load is under 350VAC, then the board must be replaced.

## TROUBLESHOOTING & REPAIR

### EXCITER CAPACITOR BANK TEST



#### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

#### DESCRIPTION

This test will determine whether there are any bad capacitors in the exciter capacitor bank. Low capacitance in the bank can cause lack of full weld output and can cause the control board to shut down the machine with an “ECH” or “ECL” error code when operating the machine at high currents.

#### MATERIALS NEEDED

Refer to “Case Cover Removal” section for tools needed to remove side panels.

Capacitance Meter

7/16” Nut Driver

Crescent Wrench

**This procedure takes approximately 35 minutes to perform.**

# TROUBLESHOOTING AND REPAIR

## EXCITER CAPACITOR BANK TEST *(continued)*



### WARNING

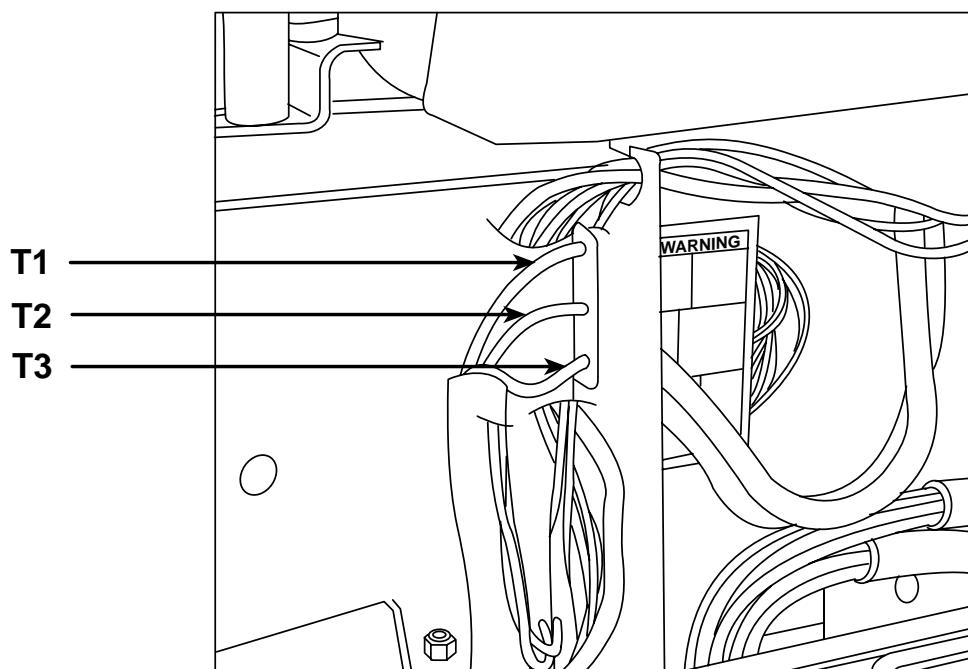


Check for voltage across capacitors. Voltages could be high and dangerous. Discharge capacitors with a high wattage (50 Ohm min.) resistor if necessary before performing tests.

### TEST PROCEDURE

1. With the engine off, disconnect the negative battery cable.
2. Refer to the **"Case Cover Removal"** section and remove the left side engine and stator cover panel.
3. Locate the point at which the capacitor bank leads are bolted to the T1, T2, & T3 leads coming from the stator and L10953-1 exciter feedback module. See Figure F.30.
4. Pull the sleeving back and disconnect the three bolted exciter connections using a 7/16" nut driver and crescent wrench.
5. Measure capacitance from multi-lead 1002/1004/1006/1008 to multi-lead 1001/1003/1005/1007 with a capacitance meter. The capacitance value should be 240 uf +/- 5%.
6. Measure capacitance from multi-lead 1018/1020/1022/1024 to multi-lead 1017/1019/1021/1023 with a capacitance meter. The capacitance value should be 240 uf +/- 5%.
7. Measure capacitance from multi-lead 1010/1012/1014/1016 to multi-lead 1009/1011/1013/1015 with a capacitance meter. The capacitance value should be 240 uf +/- 5%.
8. If any of the capacitance values in steps 5-7 are incorrect, then all the capacitors in that phase must be replaced.
9. If the test is complete, reconnect the 3 bolted connections for the T1,T2, & T3 leads from the stator and exciter module, and capacitor leads. Make sure that the T1,T2, & T3 stator leads are matched to the T1,T2,& T3 leads from the exciter module respectively. Mismatching the leads will cause the "---" or "CRS" to be stuck on the display at power up, and no weld output. Cover each bolted connection with sleeving after reconnection.
10. Reinstall the left side engine and stator cover panels per the **"Case Cover Removal"** section.

**Figure F.30 Control Board Plug J1**



COMMANDER 400



# TROUBLESHOOTING & REPAIR

## CONTROL BOARD POWER SUPPLY TEST



### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

This test will determine whether the weld control power supply from the control board that supplies power to the weld control circuit, display, 2-4 switch circuit, and CV SCR drive circuit is defective. A defective power supply can cause loss of weld output and loss of weld control.

### MATERIALS NEEDED

5/16" Nut Driver

Multi-Meter

Commander 400 Wiring Diagram (See the electrical diagrams section of this manual)

Control PC Board layout (See the electrical diagrams section of this manual)

**This procedure takes approximately 40 minutes to perform.**



# TROUBLESHOOTING AND REPAIR

## CONTROL BOARD POWER SUPPLY TEST *(continued)*

### TEST PROCEDURE

**NOTE 1:** In this test procedure, the positive output stud is used for common.

**NOTE 2:** This test procedure does not test the engine control power supply portion of the control board.

- Using the 5/16" nut driver, open the control panel and tilt out. Remove the control board cover.
- Using the control PC board layout, locate capacitor C112 (Figure F.31) and scrape the environmental coating off the negative lead. Start the machine.



### WARNING



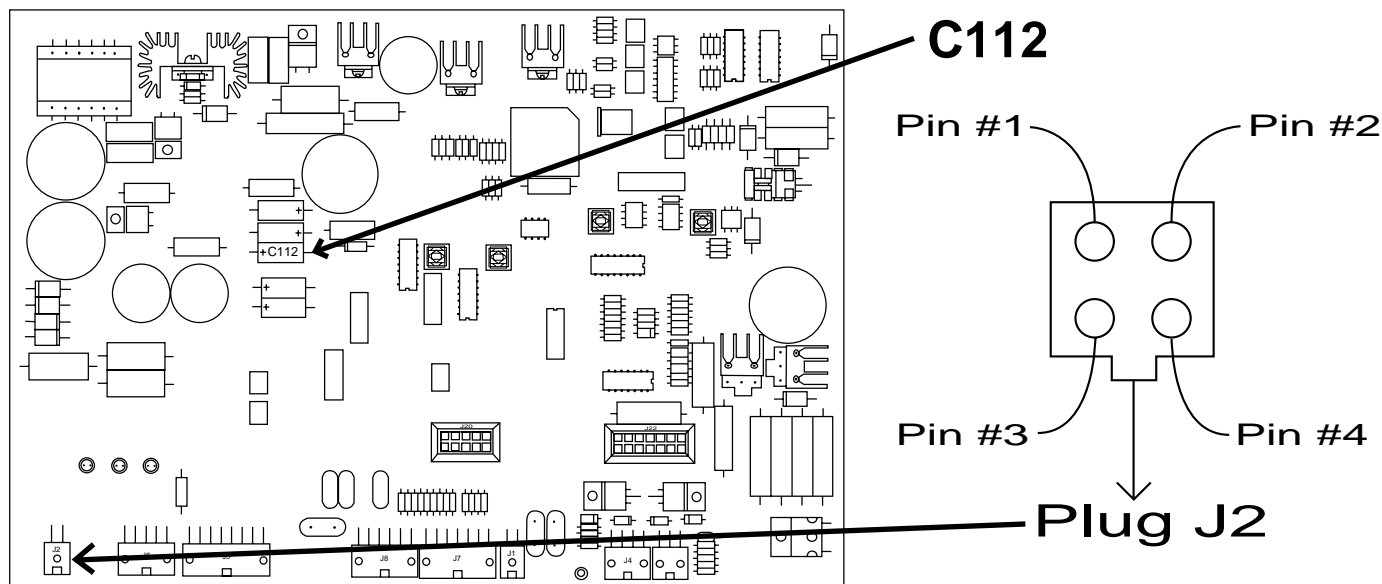
There are high voltages present inside the control box while the machine is running. **THE VOLTAGES ARE HIGH ENOUGH TO KILL.** Use extreme caution to avoid the backside of the receptacles, breakers, and terminal strip while checking voltages inside the control box.

- Refer to the **Stator Voltage Test**, step 10, to test the E1-E2 stator winding that powers the control PC board. If the voltage is correct, proceed to step 4. If the voltage is incorrect, shut down the machine, unplug J2, restart the machine, and check the voltage again at J2 pins 1 to 4. If the voltage is still incorrect, abort the "Control Board Power Supply Test" and proceed to the "Stator Resistance Test".
- With the machine running, measure the voltages at the control board per the following table.
- If any of the voltage checks in the Table F.2 below are incorrect, replace the control board.
- If the test is complete, replace the control board cover and close the control panel.

Table F.2

Measurement Point	Voltage	Description
J5 pin 2 to common	15 VDC +/- 5%	+15V supply for display
J4 pin 6 to common	10 VDC +/- 5%	+10V supply for weld control & exciter module
J5 pin 7 to common	5 VDC +/- 5%	+5V supply for microprocessor
C112 neg. lead to common	-10 VDC +/- 5%	-10V supply for weld control
J8 pin 2 to J8 pin 3	24 VDC +/- 5%	+24V supply for 2-4 circuit
J20 pin 3 to J20 pin 4	15 VDC +/- 5%	+15V supply for CV SCR gate drive circuit

Figure F.31 Control Board Plugs C112 & J2



COMMANDER 400

# TROUBLESHOOTING & REPAIR

## STATOR RESISTANCE TEST



### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

This test will determine whether there are shorts, opens, or grounds in any of the stator windings. An open, shorted or grounded winding can cause lack of output.

### MATERIALS NEEDED

Refer to "Case Cover Removal" section for tools needed to remove side panels and shroud.

5/16" Nut Driver

7/16" Nut Driver

2 Multi-Meters

Crescent Wrench

This procedure takes approximately 45 minutes to perform.

COMMANDER 400



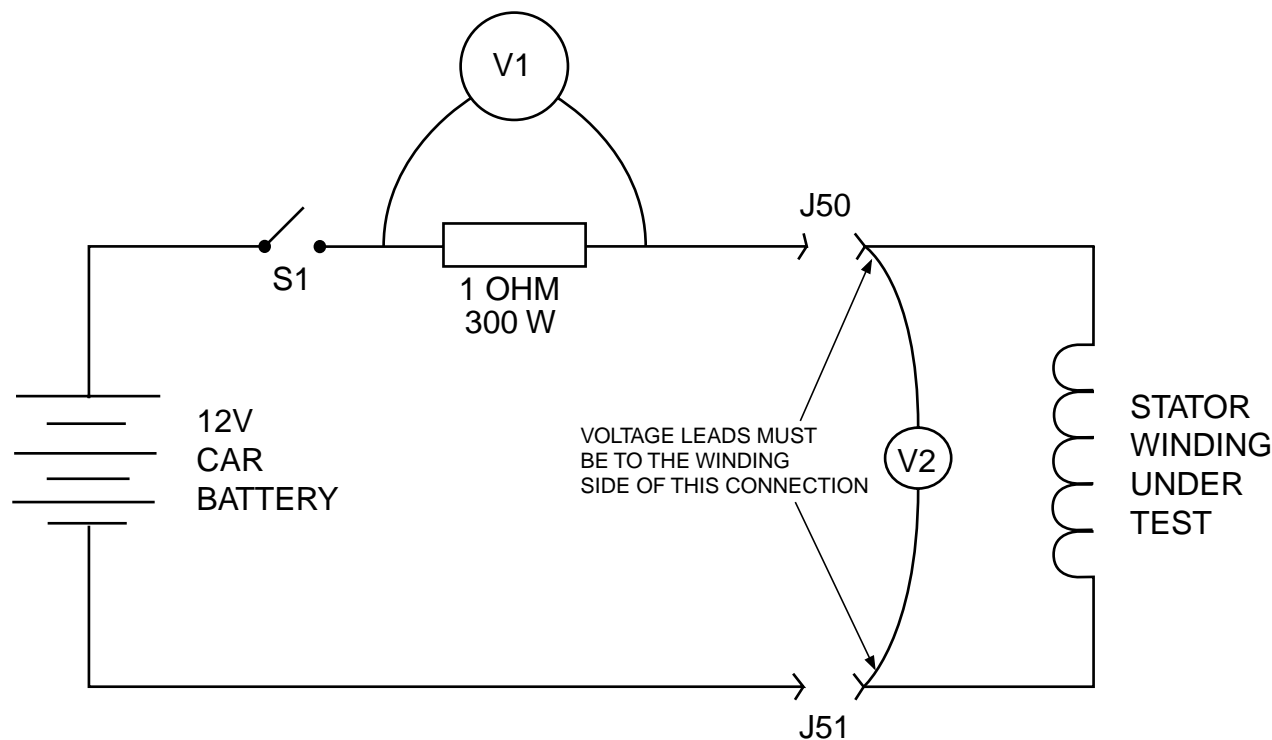
# TROUBLESHOOTING AND REPAIR

## STATOR RESISTANCE TEST (continued)

### TEST PROCEDURE

1. With the engine off, disconnect the negative battery cable. Make sure that there is nothing plugged into the 115V and 230V receptacles.
2. Using the 5/16" nut driver, open up the control panel and tilt out. Remove the control board cover.
3. Refer to the "Case Cover Removal" section and remove left side engine and stator cover panels, and the front shroud.
4. Pull the sleeving back, and disconnect all weld leads (W1-W6) from the SCR/Diode weld bridge using the 7/16" nut driver and crescent wrench.
5. Locate the point at which the capacitor bank leads are bolted to the T1, T2 & T3 leads coming from the stator and L10953-1 exciter module. Pull the sleeving back and disconnect the three bolted exciter connections using a 7/16" nut driver and crescent wrench.
6. Disconnect J2 from the control board.
7. Using an Ohmmeter check for continuity between each weld lead (W1-W6) to the T1 exciter lead. There should be no continuity between these leads.
8. Check for continuity from the weld leads to the J2 plug pins 1 & 2 at the control board. There should be no continuity between these leads. **See Figure F.31.**
9. Check for continuity from the weld leads to frame ground. There should be no continuity between these leads.
10. Check for continuity from J2 pins 1 & 4 to the T1 exciter lead. There should be no continuity between these leads.
11. Check for continuity from J2 pins 1 & 4 to frame ground. There should be no continuity between these leads.
12. Construct the circuit shown below. See Figure F.32.

Figure F.32



# TROUBLESHOOTING AND REPAIR

## STATOR RESISTANCE TEST *(continued)*

### TEST PROCEDURE

14. Connect the test leads J50 and J51 to the stator winding under test. Close S1 and read the voltages at V1 and V2, then open S1 **IMMEDIATELY**. Damage can occur to the stator winding under test if S1 is left in the "on" position for too long. **CAUTION:** The 1 ohm resistor will also become hot very quickly and can burn to the touch. Leaving the circuit on for too long can also cause the winding to heat up causing errors in measurements.

15. Use the following equation to determine the winding resistance:

$$V2/V1 = \text{winding resistance in ohms.}$$

16. Disconnect J50 and J51 from the stator winding under test. Check the resistance of all the stator windings by repeating steps 13 & 14 and using Table F.3 below.

**Table F.3**

<u>Stator Winding Under Test</u>	<u>Resistance</u>
W1 - W2	.009 ohms +/- 20%
W3 - W4	.009 ohms +/- 20%
W5 - W6	.009 ohms +/- 20%
T1 - T2	.130 ohms +/- 20%
T2 - T3	.130 ohms +/- 20%
T3 - T1	.130 ohms +/- 20%
E1 - E2 (J2 Plug)	.170 ohms +/- 20%

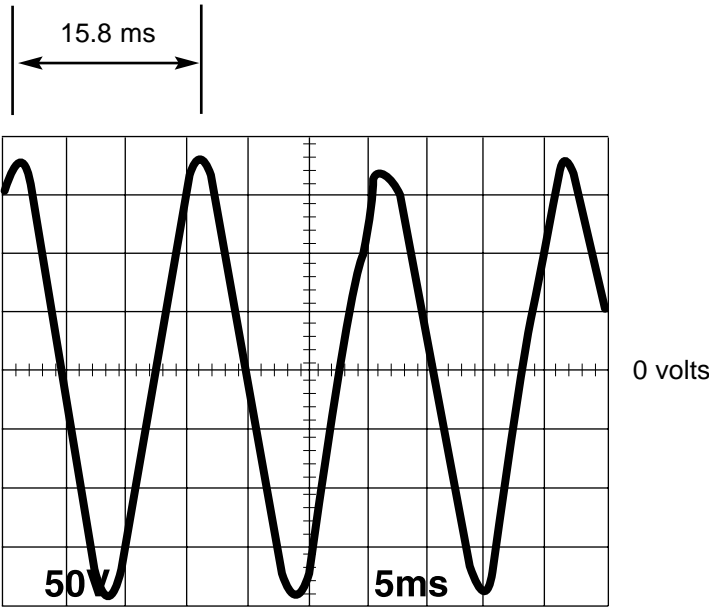
**NOTE:** The resistances in the above table are to be measured with the windings at an approximate temperature of 25 degrees Celsius (room temp.). Measuring after the windings are heated up can cause errors in the above table.

17. If any of the continuity checks fail in steps 7 thru 16, then the stator is bad. Replace.

18. If the test is complete, reconnect the 3 bolted connections for the T1, T2, & T3 leads from the stator and exciter module, and capacitor leads. Make sure that the T1, T2, & T3 stator leads are matched to the T1, T2, & T3 leads from the exciter module respectively. Mismatching the leads will cause the "---" or "CRS" to be stuck on the display at power up, and no weld output. Cover each bolted connection with sleeving after reconnection. Replace Plug J2. Reinstall the left side engine and stator cover panels and the front shroud per the "**Case Cover Removal**" section.

TROUBLESHOOTING & REPAIR

NORMAL OPEN CIRCUIT VOLTAGE WAVEFORM (115VAC SUPPLY)  
HIGH IDLE – NO LOAD – OUTPUT CURRENT CONTROL AT MAXIMUM



This is the typical auxiliary output voltage generated from a properly operating machine. Note that each vertical division represents 50 volts and that each horizontal division represents 5 milliseconds in time.

Note: Scope probes connected at machine 115VAC receptacle.

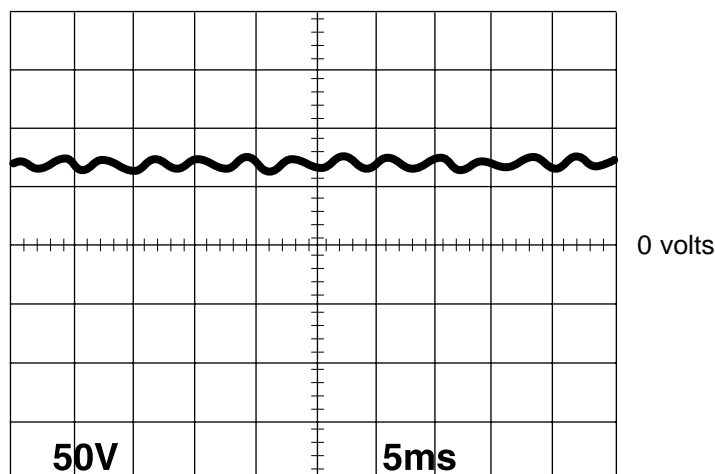
SCOPE SETTINGS

Volts/Div.....50V/Div.  
Horizontal Sweep.....5 ms/Div.  
Coupling.....DC  
Trigger.....Internal

# TROUBLESHOOTING & REPAIR

## NORMAL OPEN CIRCUIT VOLTAGE WAVEFORM (STICK)

MAX TAP – MAX CONTROL POT – HIGH IDLE – NO LOAD



This is the typical DC open circuit output voltage generated from a properly operating machine. Note that each vertical division represents 50 volts and that each horizontal division represents 5 milliseconds in time.

Note: Scope probes connected at “STICK” welding output terminals.

### SCOPE SETTINGS

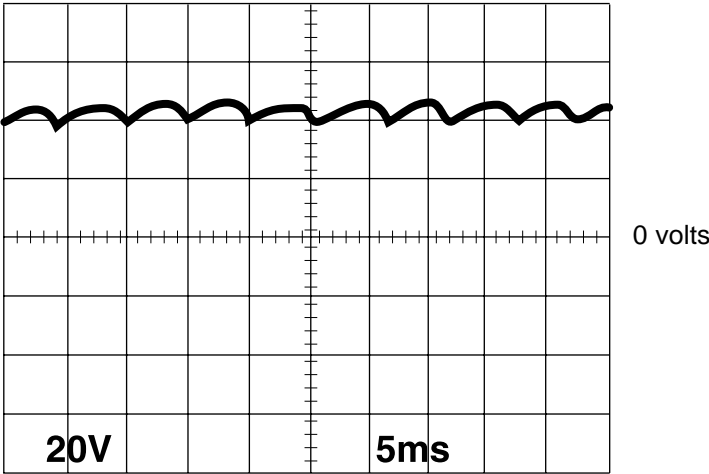
Volts/Div .....	50V/Div.
Horizontal Sweep .....	5 ms/Div.
Coupling .....	DC
Trigger .....	Internal

COMMANDER 400



TROUBLESHOOTING & REPAIR

NORMAL WELD VOLTAGE WAVEFORM (STICK CC)  
MACHINE LOADED TO 400AMPS AT 40 VOLTS



This is the typical DC output voltage generated from a properly operating machine. Note that each vertical division represents 20 volts and that each horizontal division represents 5 milliseconds in time.

The machine was loaded with a resistance grid bank to 400 amps at 40 volts.

Note: Scope probes connected at "STICK" welding output terminals.

SCOPE SETTINGS

Volts/Div .....	20V/Div.
Horizontal Sweep .....	5 ms/Div.
Coupling .....	DC
Trigger .....	Internal

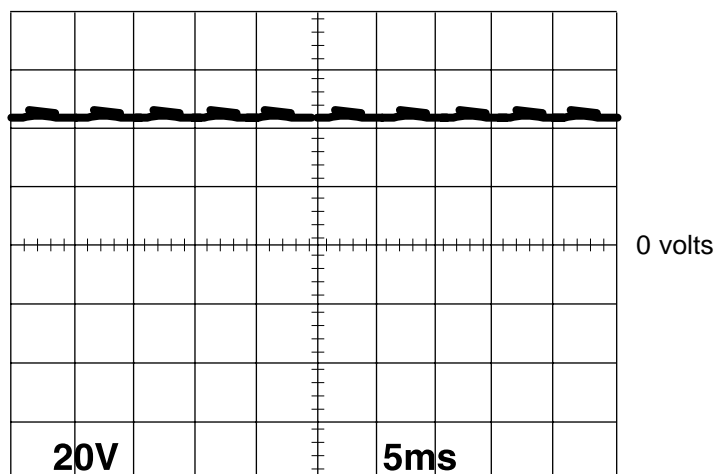




# TROUBLESHOOTING & REPAIR

## NORMAL OPEN CIRCUIT VOLTAGE WAVEFORM (WIRE CV TAP)

MAX CONTROL POT – HIGH IDLE – NO LOAD



This is the typical DC open circuit output voltage generated from a properly operating machine. Note that each vertical division represents 20 volts and that each horizontal division represents 5 milliseconds in time.

Note: Scope probes connected at "WIRE" welding output terminals.

### SCOPE SETTINGS

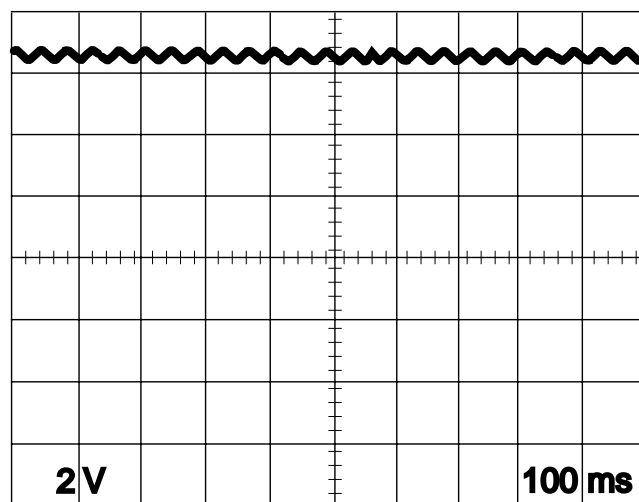
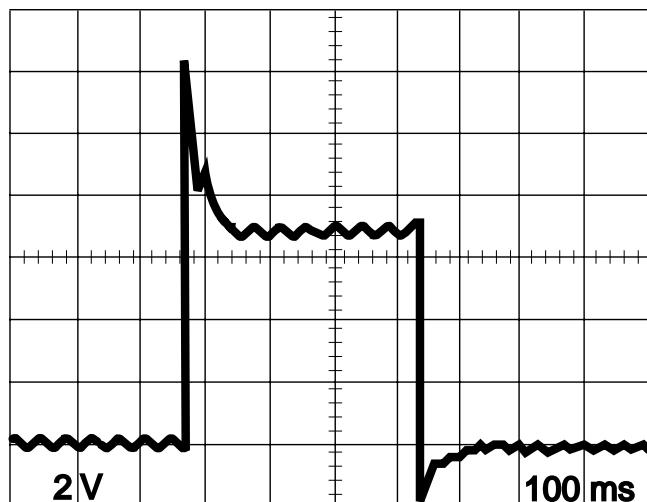
Volts/Div .....	20V/Div.
Horizontal Sweep .....	5 ms/Div.
Coupling .....	DC
Trigger .....	Internal

COMMANDER 400



## TROUBLESHOOTING &amp; REPAIR

## NORMAL SOLENOID PULL &amp; HOLD COIL WAVEFORMS



The scope pictures above are typical waveforms seen directly across the pull and hold terminals on both the Idle and Shutdown solenoids when they are operating normally.

**Note:** Voltages across the shutdown solenoid coils may be slightly lower than these waveforms since the engine alternator may not be running.

## SCOPE SETTINGS

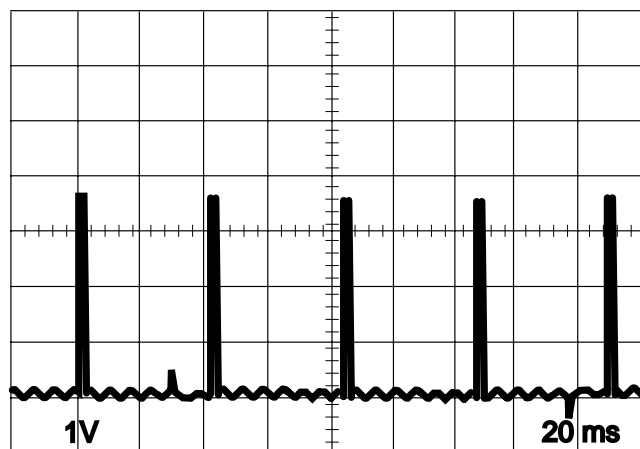
Volts/Div.....2V/Div.  
Horizontal .....100ms/Div.  
Coupling.....DC  
Trigger.....Internal

COMMANDER 400



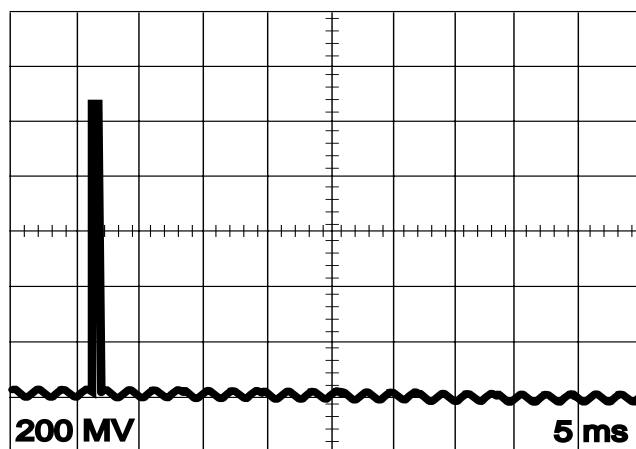
# TROUBLESHOOTING & REPAIR

## ABNORMAL SOLENOID PULL & HOLD COIL WAVEFORMS



### SCOPE SETTINGS

Volts/Div.....1V/Div.  
Horizontal Sweep ...20 ms/Div.  
Coupling.....DC  
Trigger.....Internal



### SCOPE SETTINGS

Volts/Div.....200 MV/Div.  
Horizontal Sweep .....5 ms/Div.  
Coupling.....DC  
Trigger.....Internal

The scope pictures above are examples of a short at the output of both the pull and the hold coil circuits on the control PC board. The overcurrent circuits in the pull and hold coil circuits will shut down the circuit when an overcurrent is sensed, preventing damage to the circuit. The waveform on the left will cause the solenoid to not pull in. The waveform on the right will cause the solenoid to pull in, then drop out. Check for shorted solenoid coils and grounded leads.

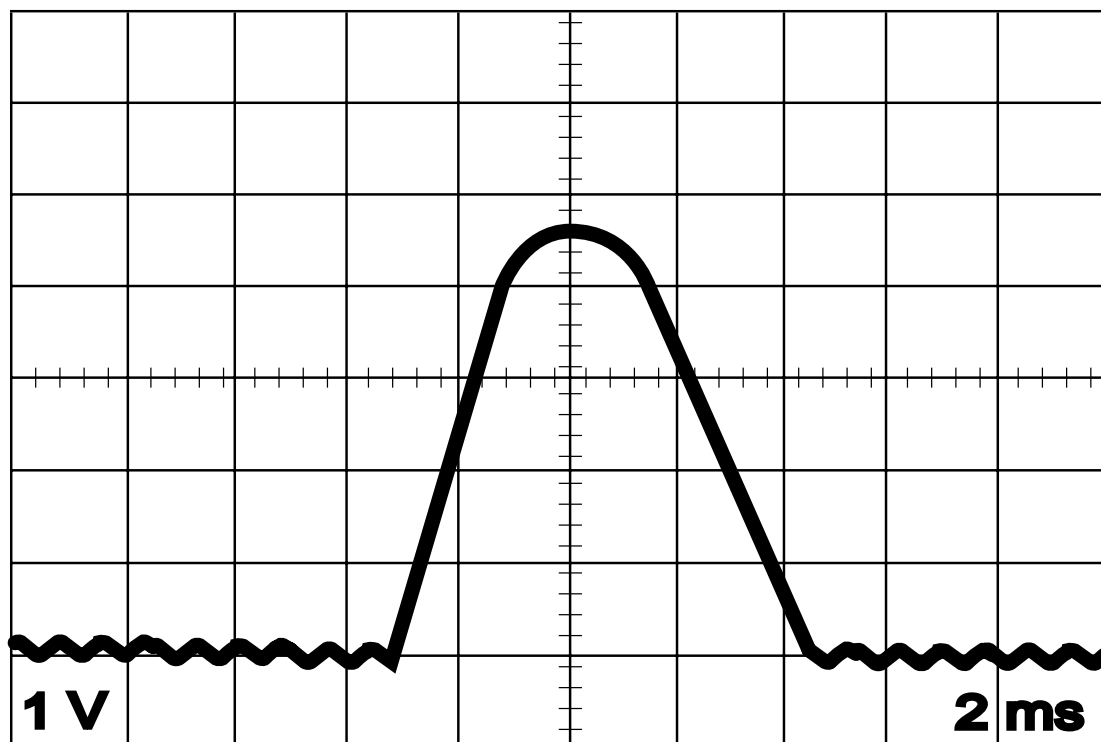
COMMANDER 400



Return to Section TOC  
Return to Master TOC  
Return to Section TOC  
Return to Master TOC  
Return to Section TOC  
Return to Master TOC  
Return to Section TOC  
Return to Master TOC

## TROUBLESHOOTING &amp; REPAIR

## TYPICAL EXCITER VOLTAGE FEEDBACK WAVEFORMS



This is the typical waveform output from each of the three phases from the Exciter Feedback Module (L10953-1) at high idle/no load under normal operation. The peak should measure between 3.5 - 4.5 Vdc, and the period should measure approximately 8.0 - 9.0 ms (make sure that the machine is set up to the proper high idle rpm before making this measurement by performing the **Engine Throttle Adjustment Test**). This waveform can be viewed at the following points on the control board:

J4 pin 1 to pin 7

J4 pin 2 to pin 7

J4 pin 3 to pin 7

## SCOPE SETTINGS

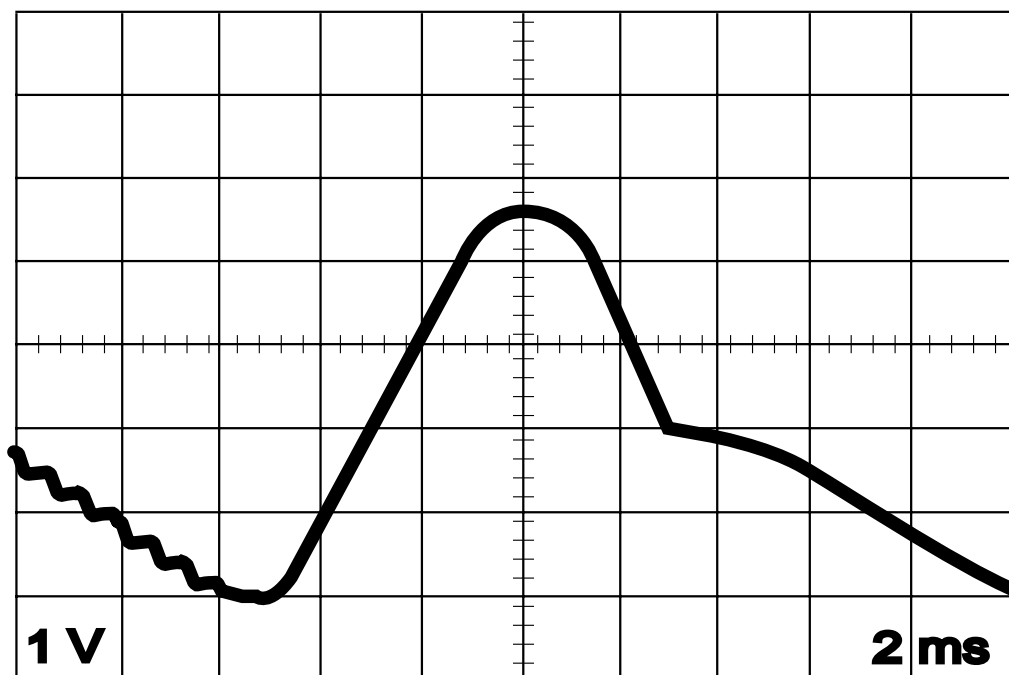
Volts/Div.....	1V/Div.
Horizontal .....	2ms/Div.
Coupling.....	DC
Trigger.....	Internal

COMMANDER 400



# TROUBLESHOOTING & REPAIR

## ABNORMAL EXCITER VOLTAGE FEEDBACK WAVEFORMS



This is an example of a bad waveform at one of the Exciter Module outputs (J4 pin 3 to pin 7).

**Note:** The distortion in the waveform that causes the period to be in excess of 9.5 ms. Any distortion that causes a period in excess of 9.0 ms requires the Exciter Module to be replaced. This distorted waveform can cause machine shutdowns with “CSS”, “ECL”, & “ECH” error codes on the display, and can cause “CRS” and “---” error codes at power-up. It can also cause flare-ups and welds that are too hot, “spattery”, or “cannon balling”.

### SCOPE SETTINGS

Volts/Div .....	1V/Div.
Horizontal .....	2ms/Div.
Coupling.....	DC
Trigger .....	Internal

COMMANDER 400



Return to Section TOC  
Return to Master TOC  
Return to Section TOC  
Return to Master TOC  
Return to Section TOC  
Return to Master TOC  
Return to Section TOC  
Return to Master TOC

## TROUBLESHOOTING & REPAIR

### CONTROL PC BOARD REMOVAL, REPLACEMENT, AND CALIBRATION

#### **⚠ WARNING**

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

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#### **DESCRIPTION**

This procedure will aid the technician in the removal and replacement of the control printed circuit board. Stick and wire models also require a calibration procedure whenever a control board is replaced. This procedure is provided here following the reassembly steps.

#### **MATERIALS NEEDED**

5/16" Nut driver  
Phillips head screw driver  
Volt/ohmmeter (for stick and wire model calibration only)

This procedure takes approximately 40 minutes to perform.

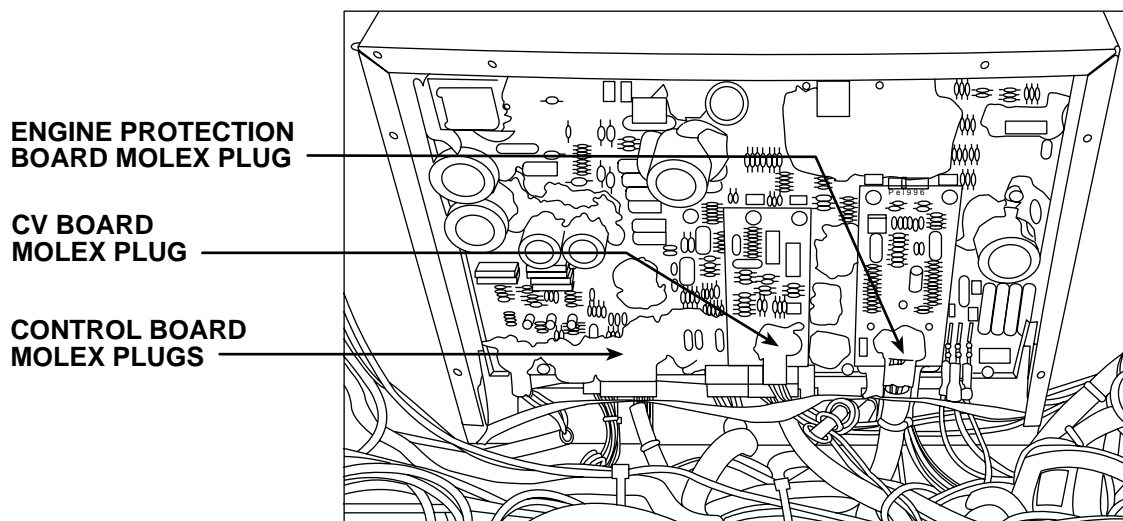
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# TROUBLESHOOTING & REPAIR

## CONTROL PC BOARD REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.33 – MOLEX PLUG REMOVAL



### PROCEDURE

Before starting the following procedure, refer to the topic ***“PC Board Troubleshooting Procedures”*** at the beginning of this section.

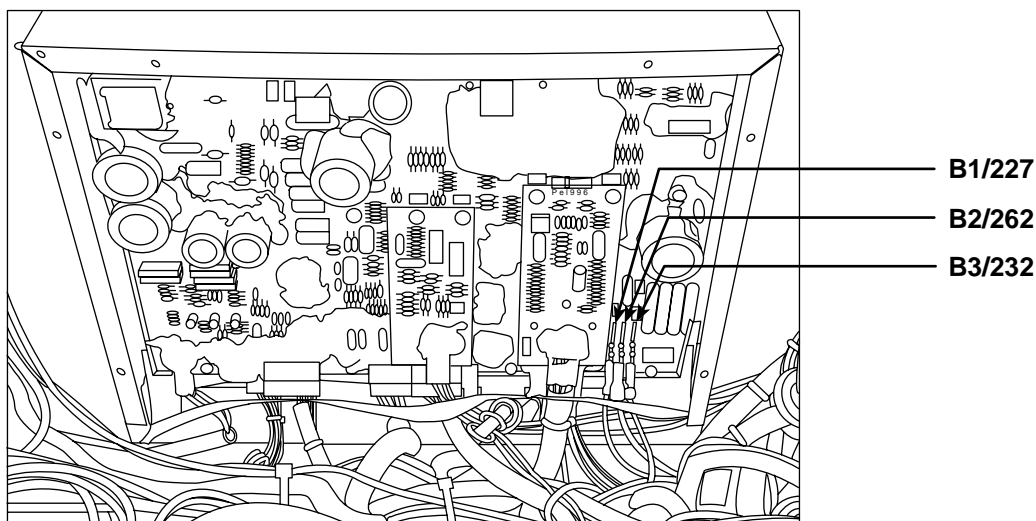
1. Turn off the engine.
2. Using the 5/16" nut driver, remove the front control cover assembly.
3. Using the 5/16" nut driver, remove the control board cover.
4. Locate and carefully remove the molex type plugs from the control board, engine protection board and CV board (if used). See Figure F.33 and the Wiring Diagram.



# TROUBLESHOOTING & REPAIR

## CONTROL PC BOARD REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.34 – CONTROL BOARD LEADS



5. Remove lead #227 from terminal B1 on the control board. See Figure F. 34.
6. Remove lead # 262 from terminal B2 on the control board. See Figure F.34.
7. Remove lead #232 from terminal B3 on the control board. See Figure F.34.
8. Note lead placement and routing through insulation for reassembly.
9. Using the phillips head screw driver, remove the control board mounting screws. Note the location of the different types of screws for reassembly. The machine screws have lock washers and flat washers, and they mount the board to welded nuts. The sheet metal screws mount to the nylon standoffs.
10. Carefully remove the control board assembly. Note insulation placement for reassembly.
11. Using the phillips head screw driver, carefully remove the engine protection board and CV board (if used).
12. Using the phillips head screw driver, carefully assemble the engine protection board and CV board (if used) to the new control board.
13. Carefully fit the control board assembly in place. Note insulation placement.
14. Using the phillips head screw driver, mount the control board with the appropriate mounting screws. The machine screws have lock washers and flat washers, and they mount the board to welded nuts. Make sure these are secure since they are used to ground the control board. The sheet metal screws mount to the nylon standoffs.
15. Attach the leads to the control board. Note lead placement and routing through insulation.  
Lead #227 to terminal B1. See Figure F. 34.  
Lead # 262 to terminal B2. See Figure F.34.  
Lead #232 to terminal B3. See Figure F.34.
16. Carefully connect the molex type plugs to the control board, engine protection board and CV board (if used). See **Figure F.33** and the Wiring Diagram.
17. Using the 5/16" nut driver, install the control board cover and the front control cover assembly.
18. Perform the following calibration procedure.

### REASSEMBLY

12. Using the phillips head screw driver, carefully assemble the engine protection board and CV board (if used) to the new control board.
13. Carefully fit the control board assembly in place. Note insulation placement.

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# TROUBLESHOOTING & REPAIR

## CONTROL PC BOARD REMOVAL AND REPLACEMENT (*continued*)

### CALIBRATION PROCEDURE

(Stick and Wire Model Only)

1. Set the front control panel as follows:

"Control" dial to 0 (Min.).  
 "Range" dial to the 'Wire Welding' setting.  
 "Idler" switch in the "Auto" position.  
 "Volts/Amps" switch to the 'volts' position.  
 "Output Control" switch to the "Welding  
 Terminals Remotely Controlled" position.

2. Connect the volt/ohm meter across the "+" and "- WIRE" (CV) terminals.

3. Start the unit.



### WARNING



**While the unit is running there are high voltages present inside the control box. THE VOLTAGES ARE HIGH ENOUGH TO KILL. Keep hands out of**

**the control box while the unit is running.**

to "AUTO." The display should read "003."

8. Set the Output Control switch to the "WELDING TERMINALS ALWAYS ON" position.
9. Turn the "Control" dial until the display reads "19.0." Assure that there is no load applied to the unit.
10. Toggle the "Idler" switch to "HIGH" and back to "AUTO" continually until the voltage on the voltmeter across the studs reads  $19.0 \pm .2$  volts. If  $19.0 \pm .2$  volts is passed by, continue to toggle the "Idler" switch to "HIGH" and back to "AUTO" and the voltage will eventually wrap around to a value below 19 volts. Continue to toggle the "Idler" switch and try to attain  $19.0 \pm .2$  volts again. Once the voltage across the terminals does read  $19.0 \pm .2$  volts, proceed to the next step.
11. Set the Output Control switch to the 'WELDING TERMINALS REMOTELY CONTROLLED" position.
12. You have now completed the calibration procedure. Disconnect the volt/ohmmeter.

4. As the unit begins to run, the display will step quickly through its initialization sequence. As soon as the display shows three dashes ("---") begin to toggle the "Idler" switch from "AUTO" to "HIGH". You must toggle the switch a total of 5 times in 5 seconds from the time that the dashes appeared on the display. Failure to do so will result in the unit defaulting to normal operation. The switch must be returned to the "AUTO" position once the test mode has been accessed. The display should read "000", indicating the step number of the self test to be executed.
5. Toggle the "Idler" switch to "HIGH" and back to "AUTO." The display should read "001."
6. Toggle the "Idler" switch to "HIGH" and back to "AUTO." The display should read "002."
7. Toggle the "Idler" switch to "HIGH" and back

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## TROUBLESHOOTING & REPAIR

### SHUTDOWN SOLENOID REMOVAL AND REPLACEMENT

#### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

#### DESCRIPTION

This procedure will aid the technician in the removal and replacement of the shutdown solenoid.

#### MATERIALS NEEDED

7/16" Wrench  
Long slot head screw driver  
Needle nose pliers

This procedure takes approximately 60 minutes to perform.

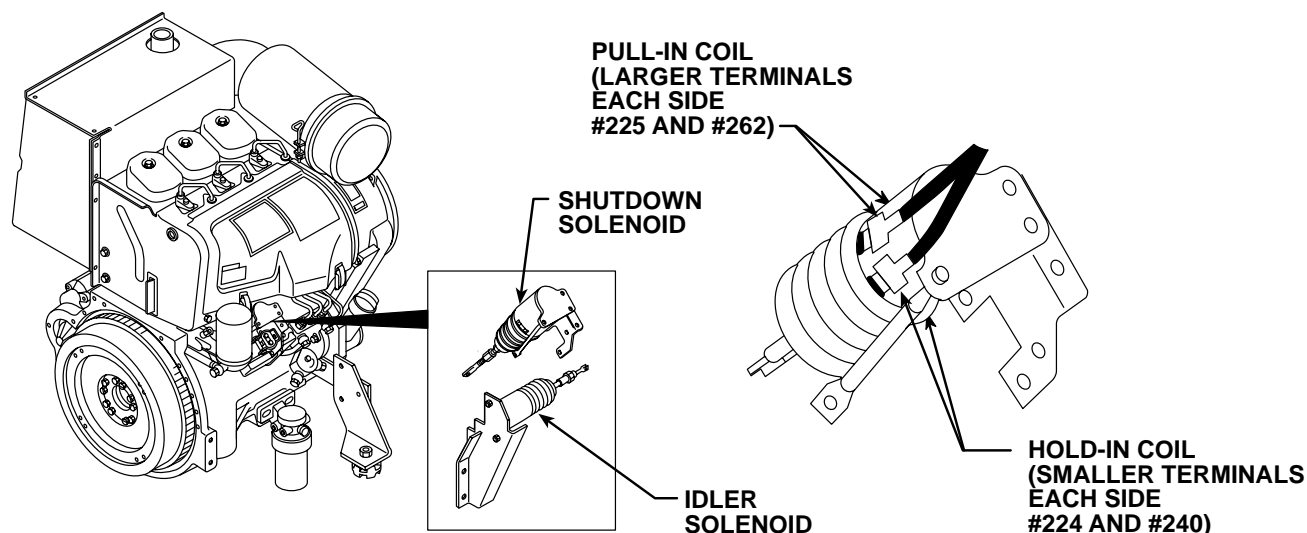
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# TROUBLESHOOTING & REPAIR

## SHUTDOWN SOLENOID REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.35 – SHUTDOWN SOLENOID LEAD CONNECTIONS



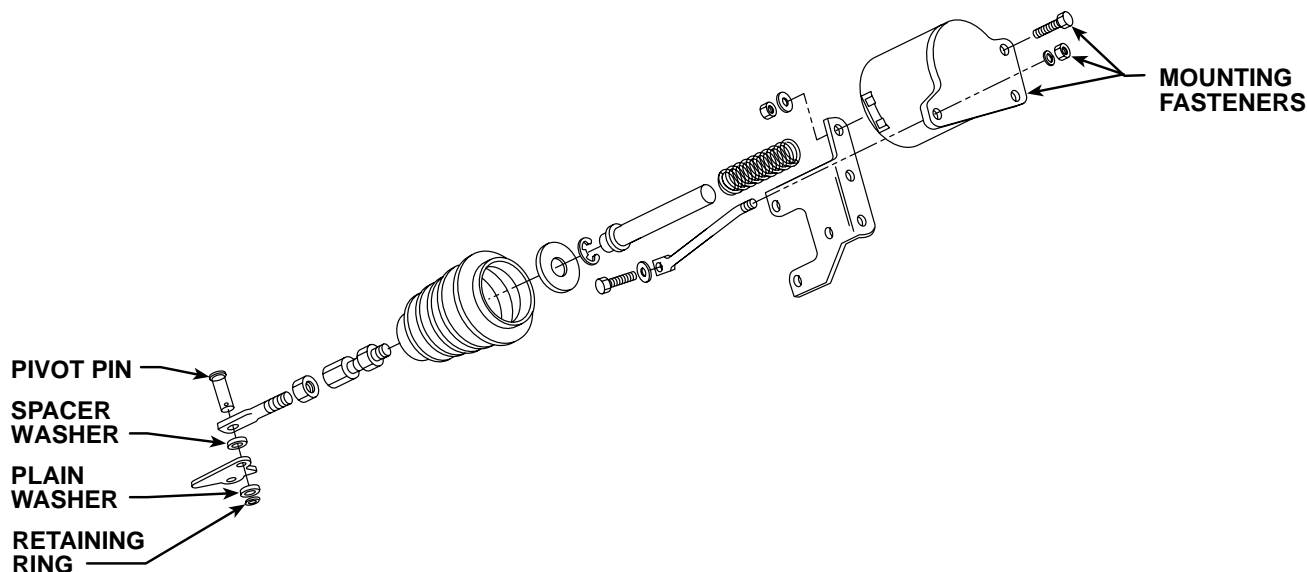
### PROCEDURE

1. Turn the engine off.
2. Unlatch, lift and secure the right side engine access door.
3. Locate and remove the four spade connectors that attach the shutdown solenoid terminals to the wiring harness leads (#224, #240, #225 and #262). See Figure F.35. Cut the cable tie.

# TROUBLESHOOTING & REPAIR

## SHUTDOWN SOLENOID REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.36 – SHUTDOWN SOLENOID LINKAGE ARM ASSEMBLY



4. Using the 7/16" wrench, remove the three nuts, two bolts and three lock washers mounting the shutdown solenoid assembly to the engine. See Figure F.36.
5. Using the long screw driver and needle nose pliers, carefully remove the retaining ring, plain washer, spacer washer and pivot pin from the linkage arm assembly. See Figure F.36.
6. Carefully remove the solenoid assembly.
7. Replace any faulty parts and reassemble the solenoid assembly.

### REASSEMBLY

8. Using the long screw driver and needle nose pliers, carefully assemble the retaining ring, plain washer, spacer washer and pivot pin to the linkage arm assembly. See figure F.36.
9. Using the 7/16" wrench, mount the shutdown solenoid assembly to the engine with three nuts, two bolts and three lock washers.
10. Attach the four spade connectors from the wiring harness leads (#224, #240, #225 and #262) to the shutdown solenoid terminals. See **Figure F.35**. Replace the cable tie.
11. Close the right side engine access door.

NOTES

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# TROUBLESHOOTING & REPAIR

## SCR/DIODE RECTIFIER BRIDGE REMOVAL AND REPLACEMENT

### **⚠ WARNING**

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

This procedure will aid the technician in the removal and replacement of the SCR/Diode rectifier bridge assembly.

### MATERIALS NEEDED

- 5/16" Nut driver
- 3/8" Wrench
- 1/2" Wrench
- 3/4" Wrench
- 11/32" Wrench

This procedure takes approximately 80 minutes to perform.

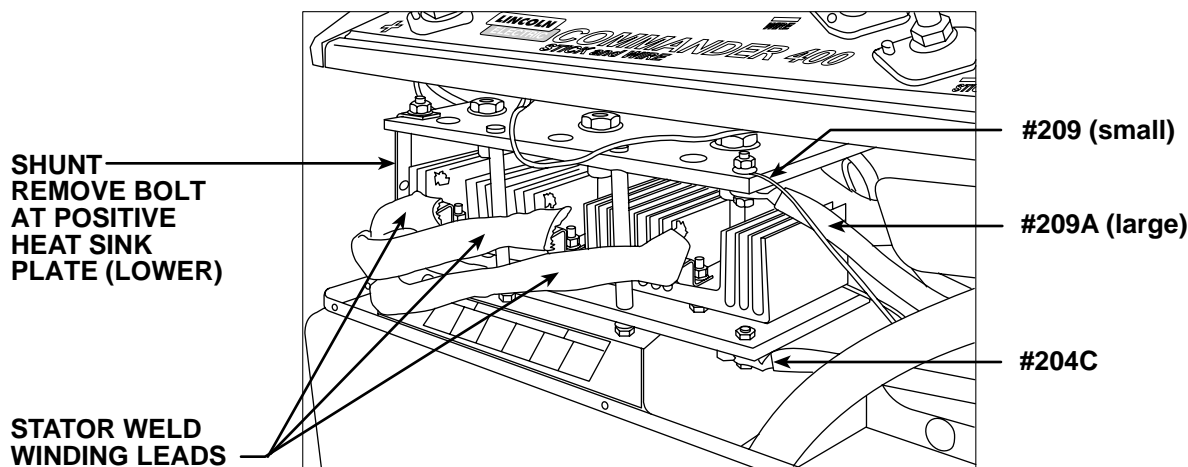
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# TROUBLESHOOTING & REPAIR

## SCR/DIODE RECTIFIER BRIDGE REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.37 – SCR/DIODE RECTIFIER BRIDGE DETAILS



### PROCEDURE

1. Turn the engine off.
2. Perform the **Case Cover Removal Procedure** (including front shroud removal).
3. Using the 1/2" wrench, remove the stator weld winding leads from the SCR/diode rectifier bridge assembly. See Figure F.37 and the Wiring Diagram. Cut any necessary cable ties and clear the leads.
4. Using the 1/2" wrench, remove lead #209 (small) and #209A (large) from the negative (upper) heat sink plate. See Figure F.37 and the Wiring Diagram.
5. Using the 1/2" wrench, remove the heavy #204C lead from the positive heat sink plate (lower). See Figure F.37 and the Wiring Diagram.
6. Using the 1/2" wrench, remove the shunt from the positive heat sink plate (lower). See Figure F.37 and the Wiring Diagram.

**NOTE:** The "DD" diode pigtail lead and the three small #204, #204A and #204B leads are also incorporated in the bolted connection. They can stay in place.

7. Using the 5/16" nut driver, remove the control board cover.
8. Remove plug J6 and the toroid assembly from the control board. Remove plug J6 and leads from the control box. Cut any necessary cable ties.

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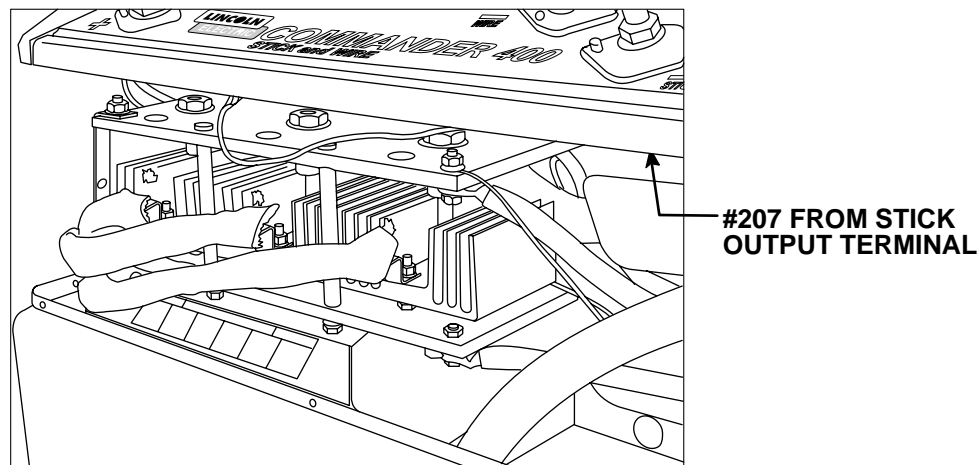




## TROUBLESHOOTING & REPAIR

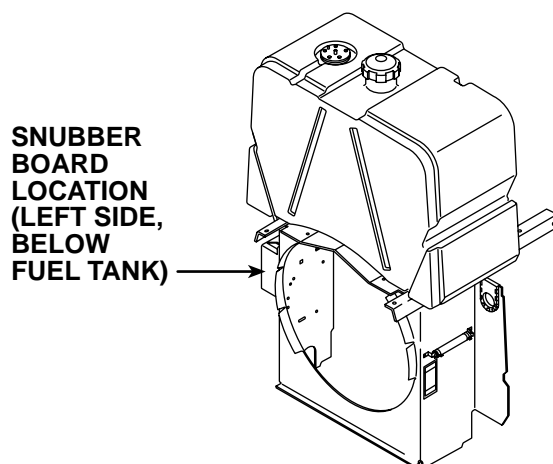
### SCR/DIODE RECTIFIER BRIDGE REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.38 – NEGATIVE "STICK" OUTPUT TERMINAL



9. Using the 3/4" wrench, remove lead #207 from the negative "stick" output terminal. See Figure F.38 and the Wiring Diagram. Cut any necessary cable ties.
10. Locate and remove the snubber board cover using the 3/8" wrench. See Figure F.39.
11. Remove plug J30 from the snubber board. See the Wiring Diagram. Clear leads for the SCR/diode rectifier bridge assembly removal.

FIGURE F.39 – SNUBBER BOARD COVER REMOVAL



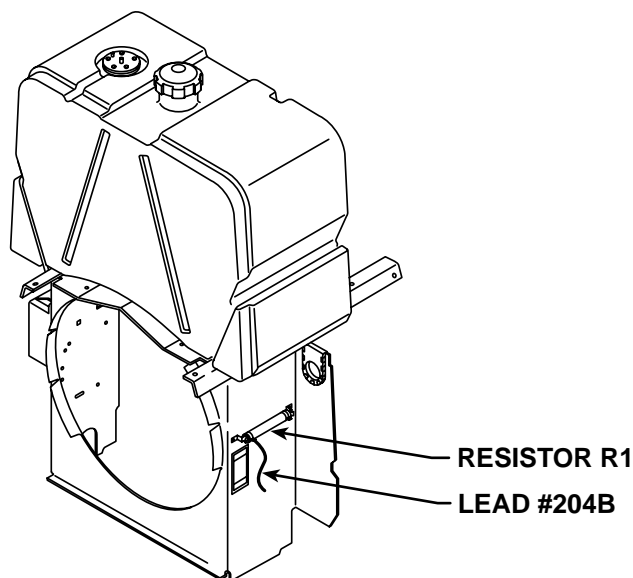
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# TROUBLESHOOTING & REPAIR

## SCR/DIODE RECTIFIER BRIDGE REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.40 – RESISTOR R1 LOCATION

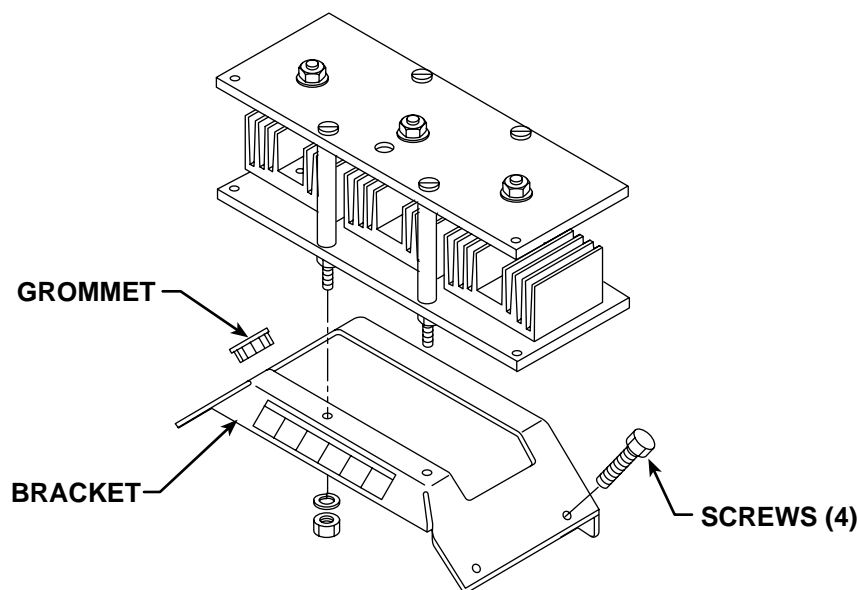


12. Using the 11/32" wrench, remove the #204B lead from the R1 (50 Ohm -100 Watt) resistor. See Figure F.40. Cut any necessary cable ties and clear leads for SCR/diode rectifier bridge assembly removal.

**NOTE:** Be sure to replace any cut cable ties on reassembly. Otherwise, the leads may catch in the blower.

13. Remove the capacitor leads and grommet from the rectifier bridge bracket. See Figure F.41.
14. Using the 3/8" wrench, remove the four (2 on each side) screws from the rectifier bridge bracket. See Figure F.41.

FIGURE F.41 – RECTIFIER BRIDGE BRACKET DETAILS



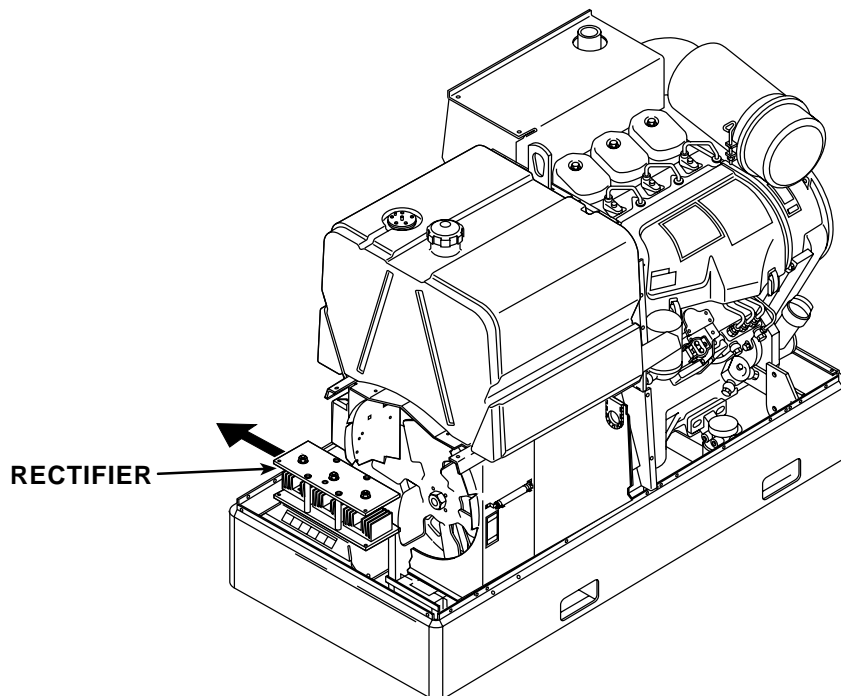
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# TROUBLESHOOTING & REPAIR

## SCR/DIODE RECTIFIER BRIDGE REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.42 – SCR/DIODE RECTIFIER BRIDGE ASSEMBLY REMOVAL



15. Carefully lift and slide the SCR/diode rectifier bridge assembly out the left side of the machine. See Figure F.42.
- REASSEMBLY**
16. Carefully lift and slide the SCR/diode rectifier bridge assembly into the machine from the left side. See Figure F.42.
  17. Using the 3/8" wrench, install the four (2 on each side) screws holding the SCR/diode rectifier bridge assembly rectifier bridge bracket. See **Figure F.41**.
  18. Attach the capacitor leads and grommet to the rectifier bridge bracket. **See Figure F.41**.
  19. Using the 11/32" wrench, attach the #204B lead to the R1 (50 Ohm -100 Watt) resistor. See **Figure F.40**.
  20. Connect plug J30 to the snubber board. Install the snubber board cover using the 3/8" wrench.
  21. Using the 3/4" wrench, attach lead #207 to the negative "stick" output terminal. Replace any cable ties cut during removal.
  22. Feed plug J6 and the toroid assembly into the control box. Connect plug J6 to the control board. Replace any cable ties cut during removal. Using the 5/16" nut driver, install the control board cover.
  23. Using the 1/2" wrench, attach the shunt to the positive heat sink plate (lower). Attach the heavy #204C lead from the positive heat sink plate (lower). Attach lead #209 (small) and #209A (large) to the negative (upper) heat sink plate. Attach the stator weld winding leads to the SCR/diode rectifier bridge assembly. Replace any cable ties cut during removal.
  24. Replace the front shroud and all case covers that were removed. (See the **Case Cover Removal and Replacement Procedure**.)
- NOTE:** Be sure to replace any cable ties cut during removal. Otherwise, the leads may catch in the blower.

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NOTES

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# TROUBLESHOOTING & REPAIR

## SCR REMOVAL AND REPLACEMENT

### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

The following procedure will aid the technician in removing the SCRs from the output rectifier heat sink for maintenance or replacement.

### MATERIALS NEEDED

NO.000 Fine Steel Wool  
Penetrox A-13 (Lincoln E2529) or Penetrox A  
7/16" Open end wrench  
Allen head type wrenches

This procedure takes approximately 50 minutes to perform.

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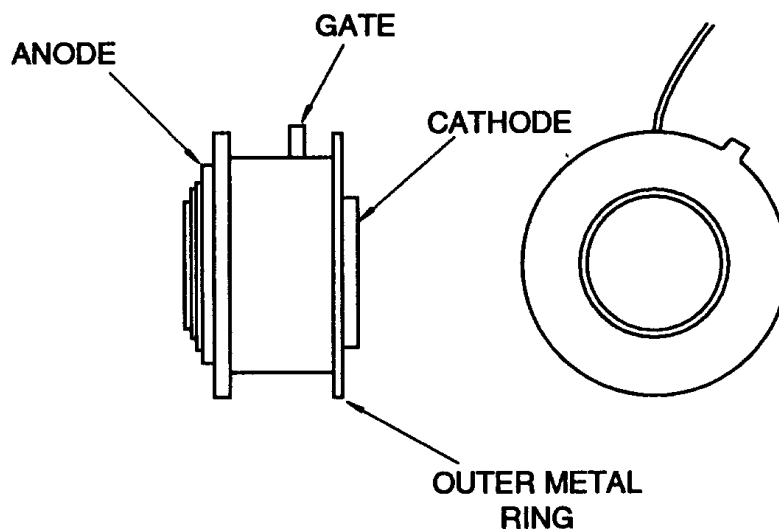


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## TROUBLESHOOTING & REPAIR

### SCR REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.43 – SCR DETAILS



#### SPECIAL INSTRUCTIONS

**NOTE:** Before disassembling the existing rectifier, note toward which heat sink the outer metal ring of the power SCR is mounted. Also, note the positioning of the gate lead of the SCR. Failure to reinstall the new SCR in the same orientation as the original may result in subsequent damage to the new SCR and other components of the welder. See Figure F.43.

#### **⚠ CAUTION**

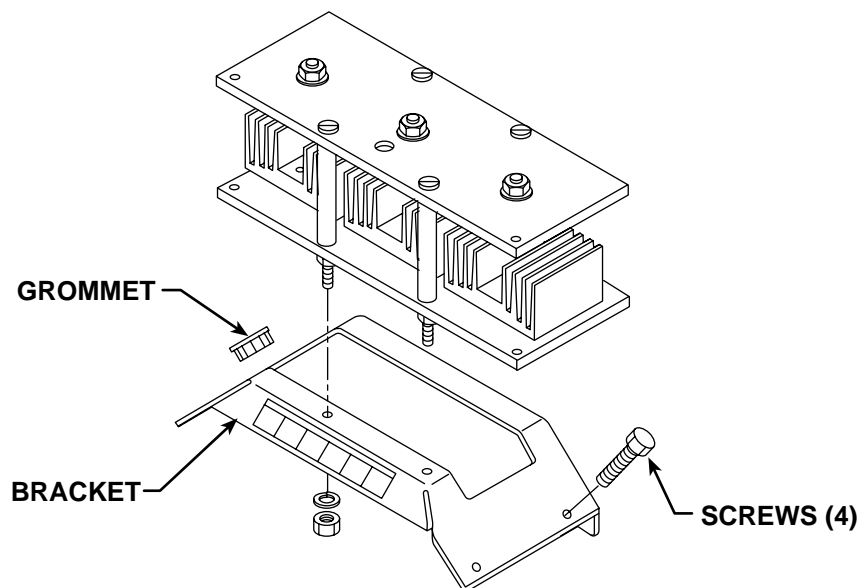
The unclamping and clamping procedure outlined below is critical for the prevention of internal SCR damage. Failure to follow this procedure may result in subsequent damage of the SCR. Handle all SCRs with care.

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# TROUBLESHOOTING & REPAIR

## SCR REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.44 – RECTIFIER BRIDGE ASSEMBLY BRACKET DETAILS



### PROCEDURE

1. Turn the engine off.
2. Perform the **SCR/Diode Rectifier Bridge Assembly Removal** procedure.
3. Using the 7/16" wrench, remove the mounting bracket for the SCR/diode rectifier bridge assembly bracket. See Figure F.44.
4. Alternately loosen nuts 1/2 turn each until heat sinks are loose. Remove nuts and leaf spring. IT IS RECOMMENDED THAT NEW HARDWARE, LEAF SPRING AND HOUSING BE USED FOR REASSEMBLY.
5. Remove the old SCR.
6. Clean the area on the heat sink around the SCR mounting surface, using a putty knife or similar tool. DO NOT SCRATCH THE SCR MOUNTING SURFACE.
7. Polish each heat sink's mounting surface using NO. 000 fine steel wool. Wipe surface clean with a lint-free cloth or paper towel.
8. Inspect the mounting surfaces of each new SCR.
  - a. Remove all burrs and wipe clean. Do not use steel wool or any abrasive cleanser on the SCR mounting surfaces.
9. Apply a thin (0.001" to 0.003") layer of PENETROX A-13 (Lincoln Electric #E2529) or PENETROX A, heat sink compound, to each heat sink's SCR mounting surface.
  - a. Care must be used to prevent foreign material contamination of the SCR to heat sink junction.
10. Place the new SCR between the heat sinks. Be sure that the outer metal ring of the SCR is facing toward the same heat sink as the old SCR's metal ring. Be sure that the roll pin of the heat sink engages the "hole" in the SCR. The SCR contact surfaces must sit flat against both heat sink surfaces.

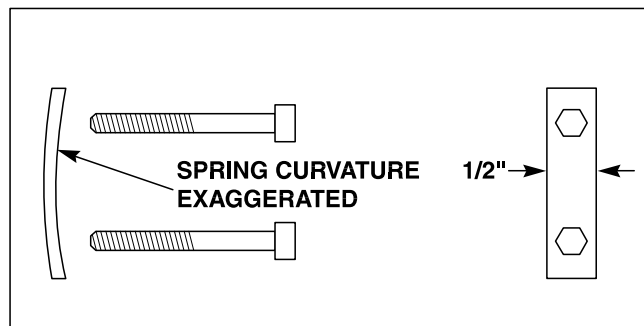
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# TROUBLESHOOTING & REPAIR

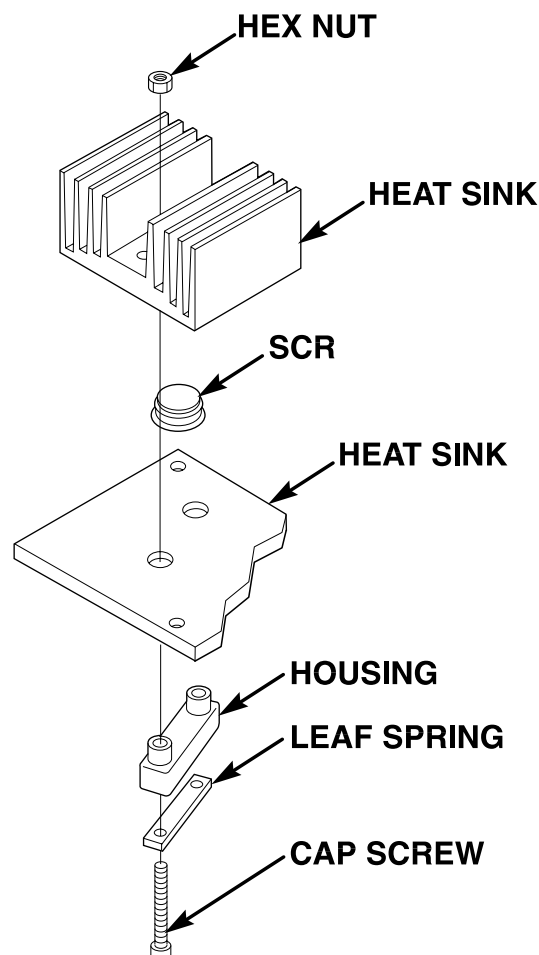
## SCR REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.45 – 1/2" WIDE LEAF SPRING



11. Go to the procedure below that matches your machine's cap screw. NOTE WHICH THREAD IS ON YOUR CAP SCREWS BEFORE PROCEEDING TO THE ASSEMBLY PROCEDURE. Two different designs of leaf springs and housings have been used to clamp the SCR to the rectifier. The two different designs can be identified by the size of the leaf spring. One design uses a 1/2 inch wide leaf spring, and the other uses a 5/8 inch wide spring. The different designs require different assembly and clamping procedures. The assembly procedure will be different depending upon the thread on the cap screws. A 1/4-28 thread requires a different tightening procedure than a 1/4-20 thread.
4. Insert clamp assembly through heat sinks. Install nuts. Tighten clamp nuts equally on cap screws until finger tight. (See Figure F.46. Heat sinks may not be exactly as pictured.)
5. Reinspect the SCR for proper seating.

FIGURE F.46 – CLAMP ASSEMBLY



### PROCEDURE FOR THE 1/2 INCH WIDE SPRING

1. Place a piece of sleeving around each cap screw.
2. Insert cap screws through the leaf spring. Orient the leaf spring so that its ends are curved upward toward the cap screw heads. See Figure F.45. Pressing on the cap screw heads should produce a "rocking" motion of the spring in its housing. If the spring does NOT rock, it is installed upside down. Remove the spring and turn it over. Check for "rocking" motion. See Figure F.45.
3. Insert cap screws and leaf spring into the plastic housing.

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# TROUBLESHOOTING & REPAIR

## SCR REMOVAL AND REPLACEMENT (*continued*)

### CLAMPING PROCEDURE FOR 1/4-28 CAP SCREWS

**NOTE:** This procedure can only be used with 1/4-28 cap screws.

Do not use cap screws with any other type thread or new SCR will be damaged.

Do not over tighten cap screws. The leaf spring will apply the required clamping force to the SCR.

1. Do not turn the nuts. While holding the nuts stationary, turn the cap screws only with the following procedure.
2. Tighten first cap screw 1/4 turn.
3. Tighten second cap screw 1/2 turn.
4. Tighten first cap screw 1/2 turn.
5. Tighten second cap screw 1/2 turn.
6. Tighten first cap screw 1/4 turn. STOP.
7. Assembly now has the proper clamping force.
8. Perform the **Active SCR Test**.

### CLAMPING PROCEDURE FOR 1/4-20 CAP SCREWS

**NOTE:** This procedure can only be used with 1/4-20 cap screws.

Do not use cap screws with any other type thread or new SCR will be damaged.

Do not over tighten cap screws. The leaf spring will apply the required clamping force to the SCR.

1. Do not turn the nuts. While holding the nuts stationary, turn the cap screws only with the following procedure.
2. Tighten first cap screw 1/4 turn.
3. Tighten second cap screw 1/2 turn.
4. Tighten first cap screw 1/2 turn.
5. Tighten second cap screw 1/2 turn.
6. Tighten first cap screw 1/4 turn. STOP.
7. Assembly now has the proper clamping force.
8. Perform the **Active SCR Test**.

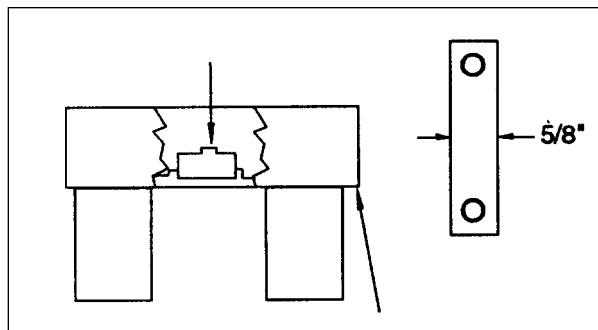
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# TROUBLESHOOTING & REPAIR

## SCR REMOVAL AND REPLACEMENT *(continued)*

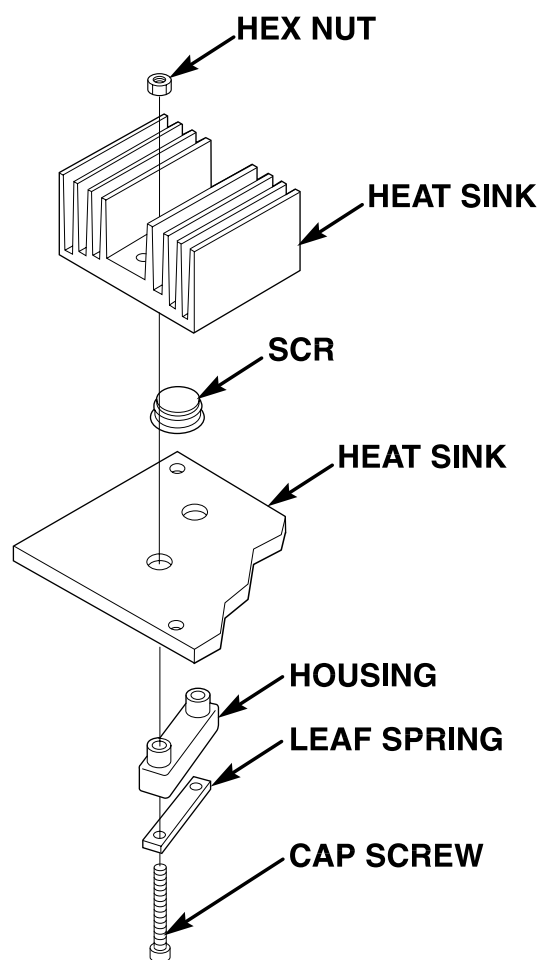
FIGURE F.47 – HOUSING AND PRESSURE PAD FOR 5/8" WIDE LEAF SPRING



### PROCEDURE FOR THE 5/8 INCH WIDE SPRING

1. Place a piece of sleeving around each cap screw.
2. Insert cap screws through the leaf spring. The leaf spring is flat so the orientation of the leaf spring does not matter.
3. Place the steel pressure pad in the housing with the 1/8 inch wide standoff facing up. See Figure F.47.
4. Insert cap screws and leaf spring into plastic housing being sure that the steel pressure pad remains in position. Pressing on the cap screw heads should produce a rocking action of the spring in its housing.
5. Insert the clamp assembly through the heat sinks. Install nuts. Tighten the clamp nuts equally on the cap screws until finger tight. Be sure that the leaf spring is not cocked in the housing. See Figure F.48. Heat sinks may not be exactly as pictured.
6. Reinspect the SCR for proper seating.

FIGURE F.48 – CLAMP ASSEMBLY



# TROUBLESHOOTING & REPAIR

## SCR REMOVAL AND REPLACEMENT (*continued*)

### CLAMPING PROCEDURE FOR 1/4-28 CAP SCREWS

**NOTE:** This procedure can only be used with 1/4-28 cap screws.

Do not use cap screws with any other type thread or new SCR will be damaged.

Do not over tighten cap screws. The leaf spring will apply the required clamping force to the SCR.

1. Do not turn the nuts. While holding the nuts stationary, turn the cap screws only with the following procedure.
2. Tighten first cap screw 1/4 turn.
3. Tighten second cap screw 1/2 turn.
4. Tighten first cap screw 1/2 turn.
5. Tighten second cap screw 1/2 turn.
6. Tighten first cap screw 1/2 turn.
7. Tighten second cap screw 1/4 turn. STOP.
8. Assembly now has the proper clamping force.
9. Perform the **Active SCR Test**.

### AFTER REPLACING THE SCRs

Follow the steps in the **SCR/Diode Rectifier Bridge Removal and Replacement** procedure to reassemble the machine.

### CLAMPING PROCEDURE FOR 1/4-20 CAP SCREWS

**NOTE:** This procedure can only be used with 1/4-20 cap screws.

Do not use cap screws with any other type thread or new SCR will be damaged.

Do not over tighten cap screws. The leaf spring will apply the required clamping force to the SCR.

1. Do not turn the nuts. While holding the nuts stationary, turn the cap screws only with the following procedure.
2. Tighten first cap screw 1/4 turn.
3. Tighten second cap screw 1/2 turn.
4. Tighten first cap screw 1/2 turn.
5. Tighten second cap screw 1/4 turn.
6. Tighten first cap screw 1/8 turn.
7. Tighten second cap screw 1/8 turn. STOP.
8. Assembly now has the proper clamping force.
9. Perform the **Active SCR Test**.

NOTES

Return to Section TOC	Return to Section TOC	Return to Section TOC	Return to Section TOC
Return to Master TOC	Return to Master TOC	Return to Master TOC	Return to Master TOC



## TROUBLESHOOTING & REPAIR

### MOUNTING OF STUD TYPE DIODES TO ALUMINUM HEAT SINKS

#### **WARNING**

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

#### **DESCRIPTION**

The following procedure will aid the technician in mounting stud type diodes to the aluminum heat sinks on the Commander 400.

#### **MATERIALS NEEDED**

- 5/16" Nut driver
- 1/2" Open end wrench
- Lincoln E1868 (Dow Corning 340) Heat Sink Compound
- "Slip" type torque wrench
- No. 000 fine steel wool

This procedure takes approximately 30 minutes to perform.

**COMMANDER 400**



MOUNTING OF STUD TYPE DIODES TO ALUMINUM  
HEAT SINKS *(continued)*

PROCEDURE

1. Turn the engine off.
2. Perform the **SCR/Diode Bridge Removal Procedure**.
3. Loosen the appropriate diode nut and remove the diode that is to be replaced.
4. Clean the area on the heat sink around the diode mounting surface using a putty knife or similar tool. DO NOT SCRATCH THE DIODE MOUNTING SURFACE.
5. Polish each heat sink's mounting surface using No. 000 fine steel wool. Wipe the surface clean with a lint-free cloth or paper towel.
6. Inspect the mounting surfaces of each new diode. Remove all burrs and wipe clean. Do not use steel wool or any abrasive cleanser on the diode mounting surface.
7. Apply a thin (0.003" to 0.007") uniform layer of E1868 (Dow Corning 340) heat sink compound to the heat sink mounting surface.
  - a. Do not apply compound to the diode stud or mounting threads.
  - b. The diode threads must be clean and free of defects so that the nut can be finger tightened before applying torque. A "slip" type torque wrench must be used to tighten the diode nut.

8. Tighten the diode nuts to the specifications in the following table.
  - a. Start the nuts for diodes with steel studs by hand and then torque them according to the following table.
  - b. Run the nuts for diodes with copper studs on all the way by hand then torque them according to Table F.4 below.
  - c. Turn the nuts a minimum of 1/2 turn more while torquing.

Table F.4

DIODE STUD SIZE	FOOT-POUNDS	INCH-POUNDS
3/4-16	25-27	300-324
3/8-24	10±.5	125+0/-5
1/4-28		22-25

9. Perform **SCR/Diode Bridge Replacement Procedure**.

10. Install the case top and sides.

# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT

### WARNING

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual.

If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-800-833-9353 (WELD).

### DESCRIPTION

This procedure will aid the technician in the removal and replacement of the engine and stator assembly. This is necessary in order to gain access the stator and/or rotor.

### MATERIALS NEEDED

- 5/16" Nut driver
- 3/8" Wrench
- 1/2" Wrench
- 9/16" Socket Wrench
- 11/16" Socket Wrench
- 7/16" Wrench
- 3/4" Wrench
- 3/4" Socket Wrench
- Slot head screw driver
- Hoist (CHECK WEIGHT LIMITATIONS)
- Pliers
- 5/8" Wrench
- 1/4" Allen type wrench
- 1-13/32" Socket wrench

This procedure takes approximately 8 hours to perform.

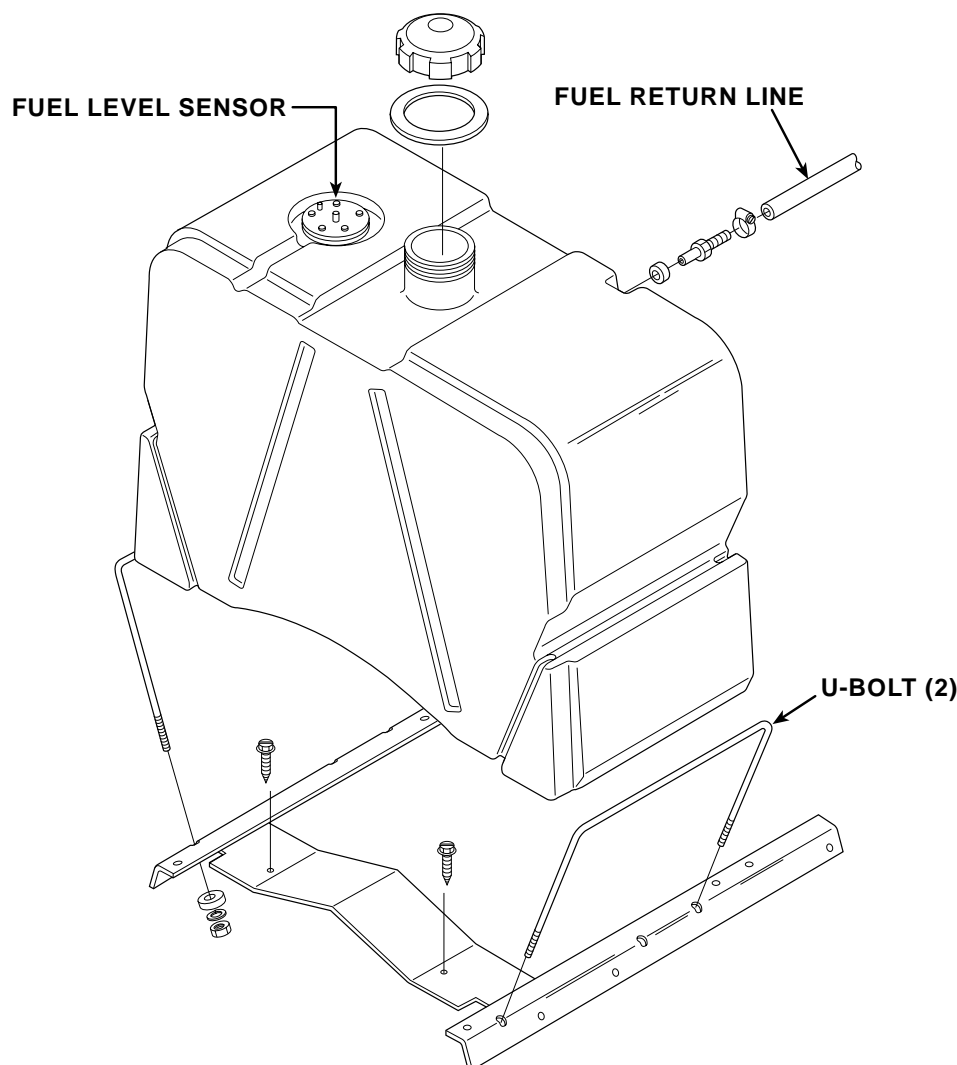
COMMANDER 400



# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.49 – FUEL TANK REMOVAL DETAILS



### PREPARATION AND LEAD REMOVAL PROCEDURE

1. Turn the engine off.
2. Using the 3/8" and 1/2" wrenches, remove the battery cover and disconnect the battery. Remove the battery by sliding it out.
3. Perform the **Case Cover Removal Procedure** (including removing the front shroud).
4. Using the 3/8" wrench, remove leads #242E and #229 from the fuel level sensor. See Figure F.49. Label the leads for reassembly.
5. Turn the fuel off at the shutoff valve. Remove and plug the fuel return line. See Figure F.49.
6. Remove and plug the lower fuel line. See Figure F.49.
7. Using the 9/16" socket wrench, remove the four nuts, washers and rubber washers from the fuel tank mounting U-bolts. See Figure F.49.
8. Carefully remove the U-bolts and lift the fuel tank away from the machine.

COMMANDER 400

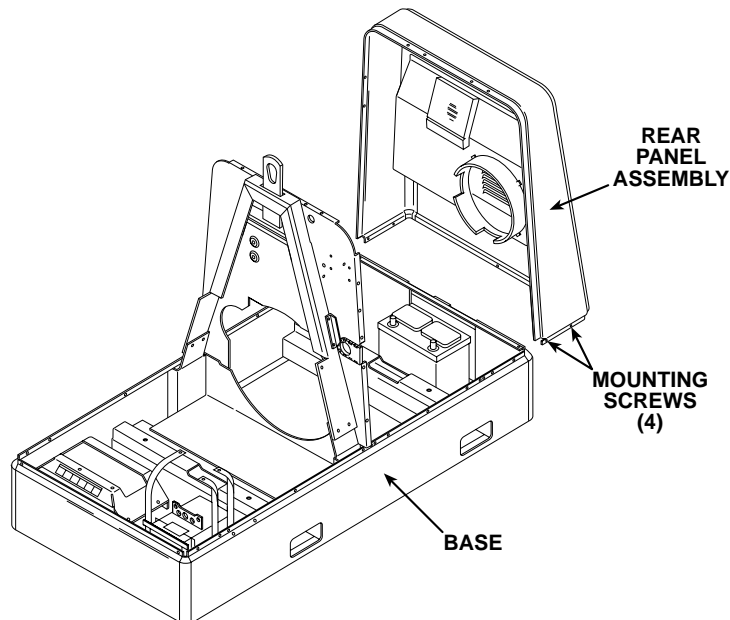




# TROUBLESHOOTING & REPAIR

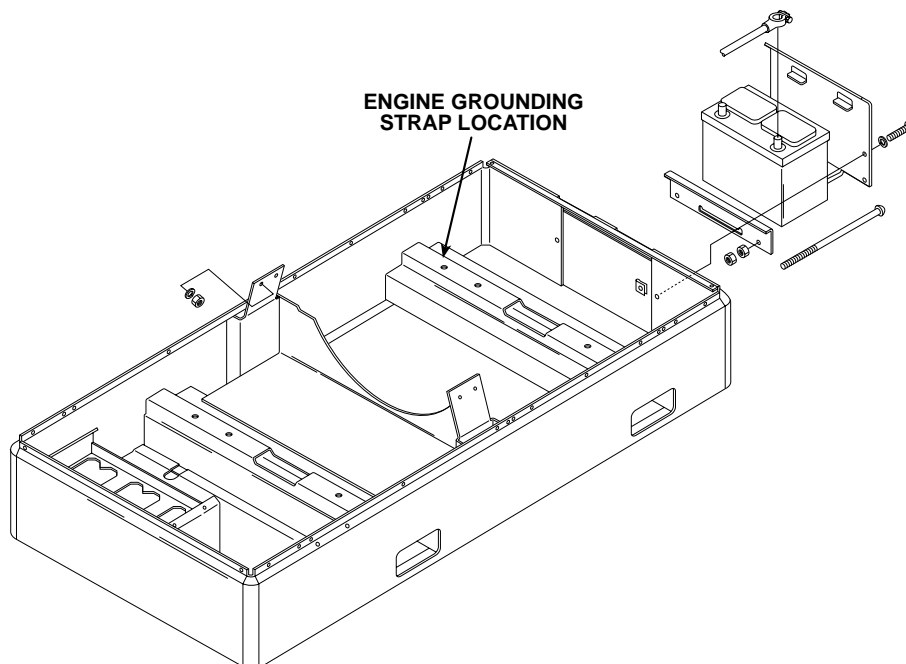
## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.50 – REAR PANEL ASSEMBLY REMOVAL DETAILS



9. Using the 3/8" wrench, remove the screws holding the rear panel assembly to the machine base. See Figure F.50.
10. Lift and remove the rear panel assembly.
11. Using the 9/16" wrench, remove the engine grounding strap. See Figure F.51.

FIGURE F.51 – GROUNDING STRAP REMOVAL

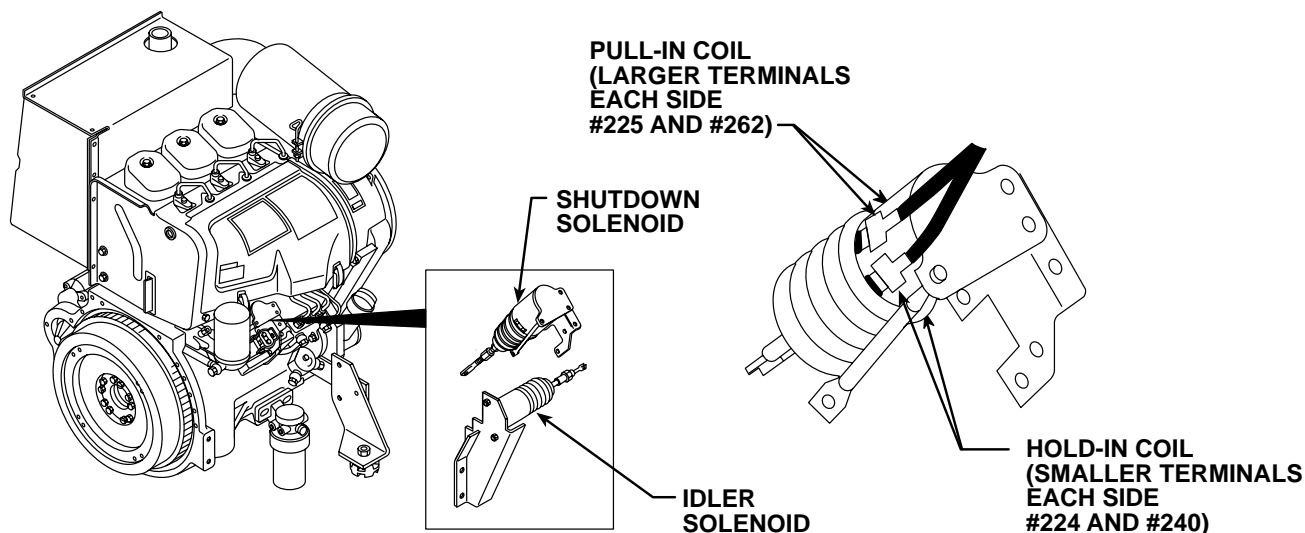


COMMANDER 400

# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT *(continued)*

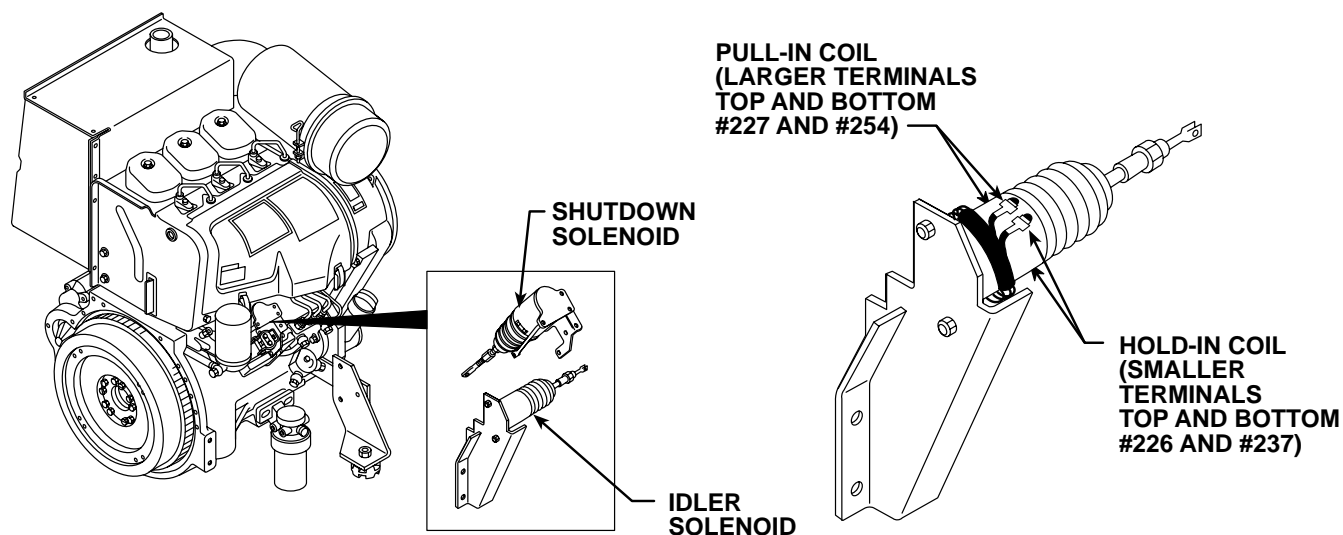
FIGURE F.52 – SHUTDOWN SOLENOID LEAD REMOVAL



12. Label and remove the four leads #224, #240, #225 and #262 from the shutdown solenoid. See Figure F.52. Cut any necessary cable ties.

13. Label and remove leads #226, #237, #227 and #254 from the idler solenoid. See Figure F.53. Cut any necessary cable ties.

FIGURE F.53 – IDLER SOLENOID LEAD REMOVAL

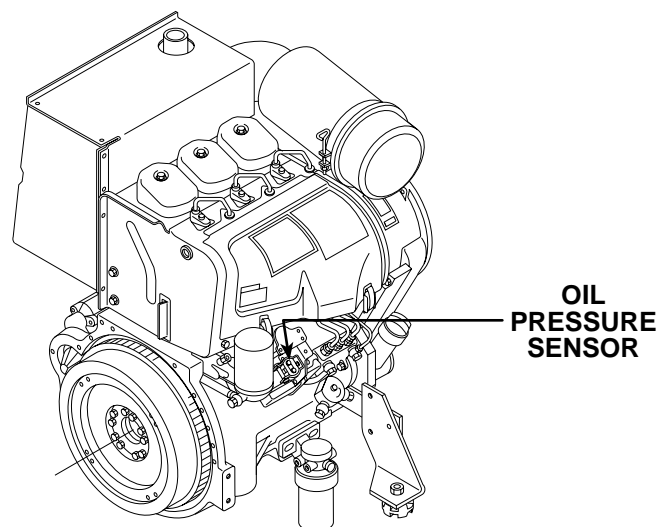


COMMANDER 400

# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT (*continued*)

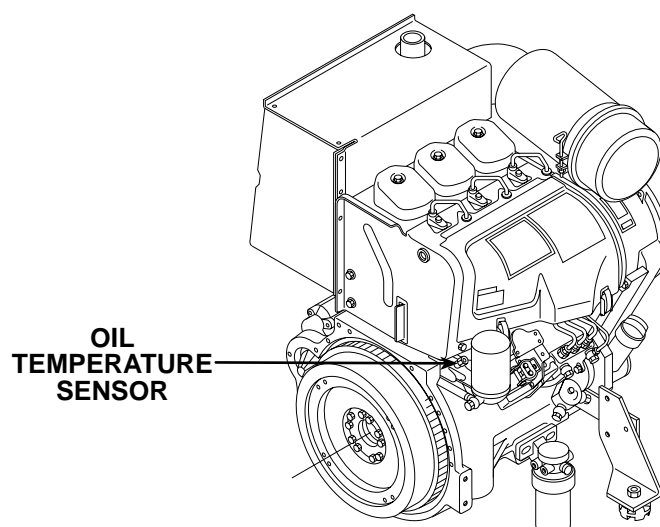
FIGURE F.54 – OIL PRESSURE SENSOR LEAD REMOVAL



14. Label and remove leads #228 and #234 from the oil pressure sensor. See Figure F.54.

15. Label and remove leads #233A and #241 from the oil temperature sensor. See Figure F.55.

FIGURE F.55 – OIL TEMPERATURE SENSOR LEAD REMOVAL



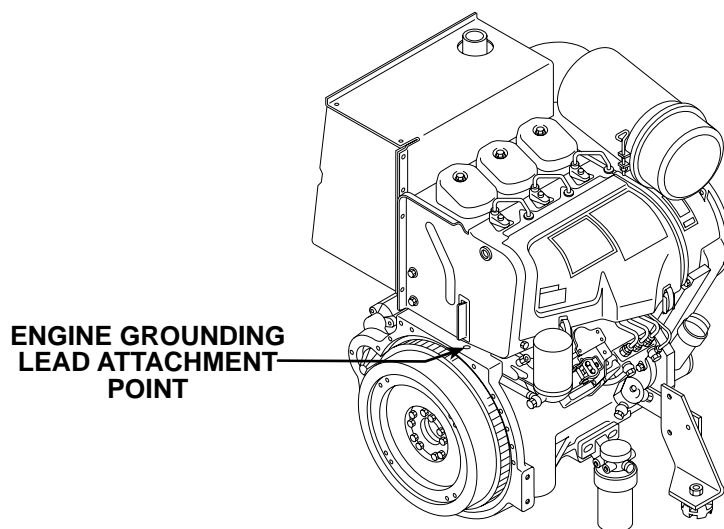
COMMANDER 400



# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.56 – ENGINE GROUNDING LEAD

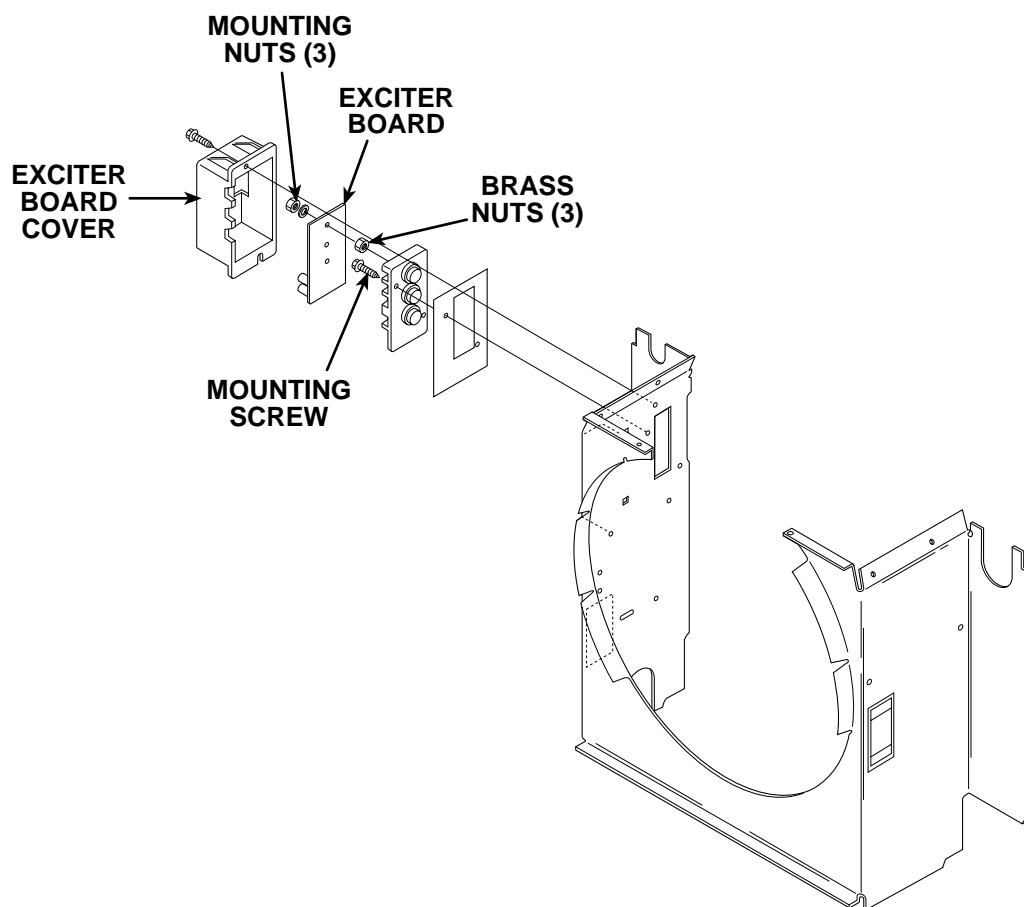


16. Using the 11/16" socket wrench, remove the grounding lead from the top of the engine bell housing. See Figure F.56.
17. Cut any necessary cable ties to free the harness assembly from the engine/stator assembly.
18. Using the 11/16" wrench, remove leads #236A, #236B and #236C from the starter motor solenoid.
19. Using the slot head screw driver, remove lead #231A and #231B from the starter motor solenoid.
20. Label and remove the #239 lead from the engine alternator using the 3/8" wrench.
21. Label and remove the #285 lead from the engine alternator using the 3/8" wrench.
22. Label and remove the #238 lead from the engine alternator using the 7/16" wrench.
23. Clear the wiring harness for engine/stator removal by cutting any necessary cable ties.
24. Using the 1/2" wrench, remove the three bundled leads (W1-W4, W2-W5 and W3-W6) from the SCR/diode rectifier bridge assembly.

## TROUBLESHOOTING &amp; REPAIR

ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.57 – EXCITER BOARD COVER REMOVAL



25. Using the 3/8" nut driver, remove the exciter board cover. This is sealed and may require some gentle prying to dislodge. See Figure F.57.

### ⚠ WARNING

**ELECTRIC SHOCK can kill.**



- Do not operate with panels open.
- Disconnect **NEGATIVE (-) BATTERY LEAD** before servicing.

- Do not touch electrically live parts.

26. Check for voltage at the three studs. If voltage is present, do not proceed. Call the Lincoln Electric Service Dept. at 1-800-833-9353.

With the 7/16" wrench, remove the three nuts and washers that mount the exciter board to the three studs. With the 1/4" nut driver, remove the lower mounting screw from the exciter board.

27. With the 7/16" wrench, remove the three brass nuts and label and remove the T1, T2 and T3 stator leads (only) from the studs. Cut any necessary cable ties. With the 5/16" nut driver, remove the screws and drop the case front to access the control box. Remove the control board cover.

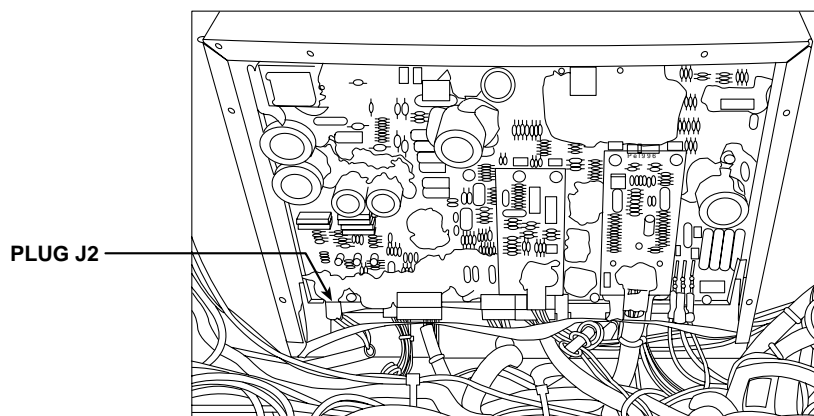
COMMANDER 400



# TROUBLESHOOTING & REPAIR

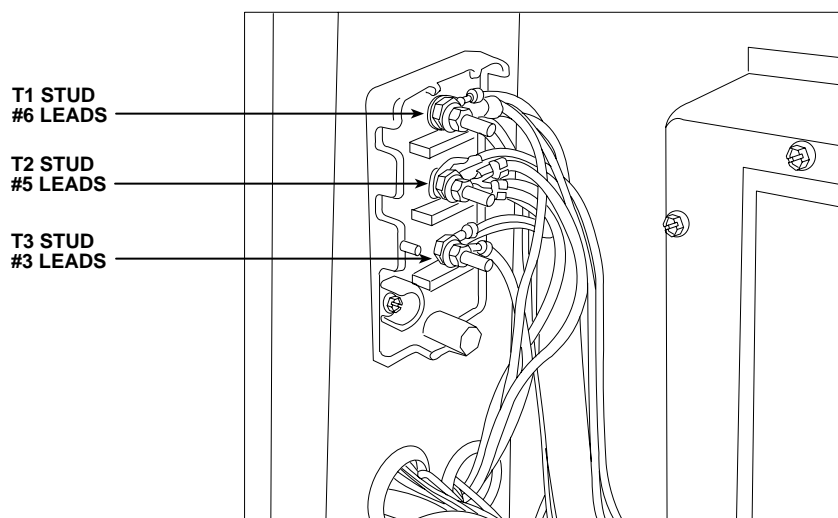
## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.58 – CONTROL BOARD PLUG J2 LOCATION



28. Locate and remove plug J2 from the control board. See Figure F. 58. Thread plug J2 out of the control box.
29. Label leads 5 and 5A at the neutral T2 stud (center stud) in the control box. Using the 7/16" wrench remove the leads. See Figure F.59.
30. Using the 7/16" wrench remove lead #6 from the T1 stud (top stud) in the control box. Label and remove the lead from the control box. Remove the #6 lead from the toroid assembly. See Figure F.59. Note the number of turns and the direction of the lead through the toroid hole. See the Wiring Diagram. Cut any necessary cable ties.
31. Label the #3 lead from the T3 stud in the control box. Using the 7/16" wrench, remove the #3 lead from the control box. Remove the #3 lead from the toroid assembly. See Figure F.59. Note the number of turns and the direction of the lead through the toroid hole. See the Wiring Diagram. Clear the leads for stator removal.

FIGURE F.59 – CONTROL BOX STUD TERMINALS

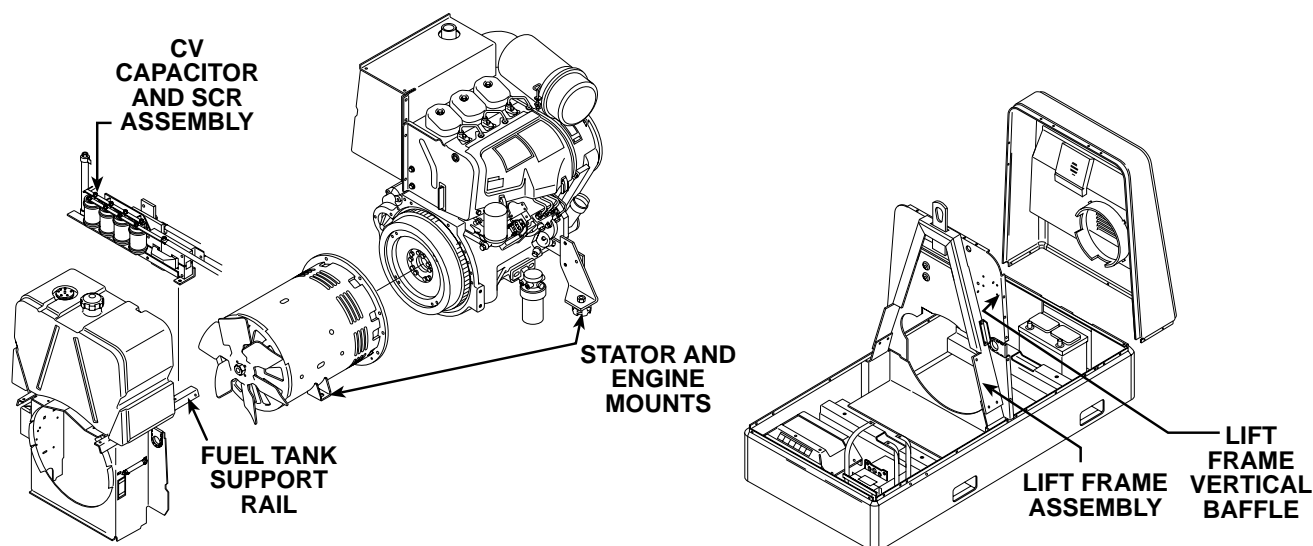


COMMANDER 400

# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.60 – VERTICAL BAFFLE /ENGINE MOUNT REMOVAL



32. Using the 3/8" wrench, remove the eight screws that mount the lift frame vertical baffle to the lift frame assembly. See Figure F. 60. Also remove the engine access door chain, noting its placement and length for reassembly.
33. Using the 1/2" wrench, remove the two screws holding the CV capacitor and SCR assembly to the fuel tank support rails. See Figure F.60.
34. Move the CV capacitor and SCR assembly toward the front of the machine to allow clearance for the engine/stator removal.
35. Using the 1/2" wrench and 5/16" nut driver, remove the tank/fan guard. See Figure F.60..
36. Using the 3/4" wrench and socket wrench, remove the four engine and stator mounting nuts, spacers, rubber mounts and bolts. See Figure F.60.
37. Using the hoist, carefully lift and remove the engine/stator assembly, being careful to balance the unit. Be sure to remove the lead bundles W1 through W6 from the lower left side fan shroud. Set the engine/stator assembly on secure blocks for support and for the stator removal procedure. Be sure the engine/stator assembly is secure on the blocks.

COMMANDER 400



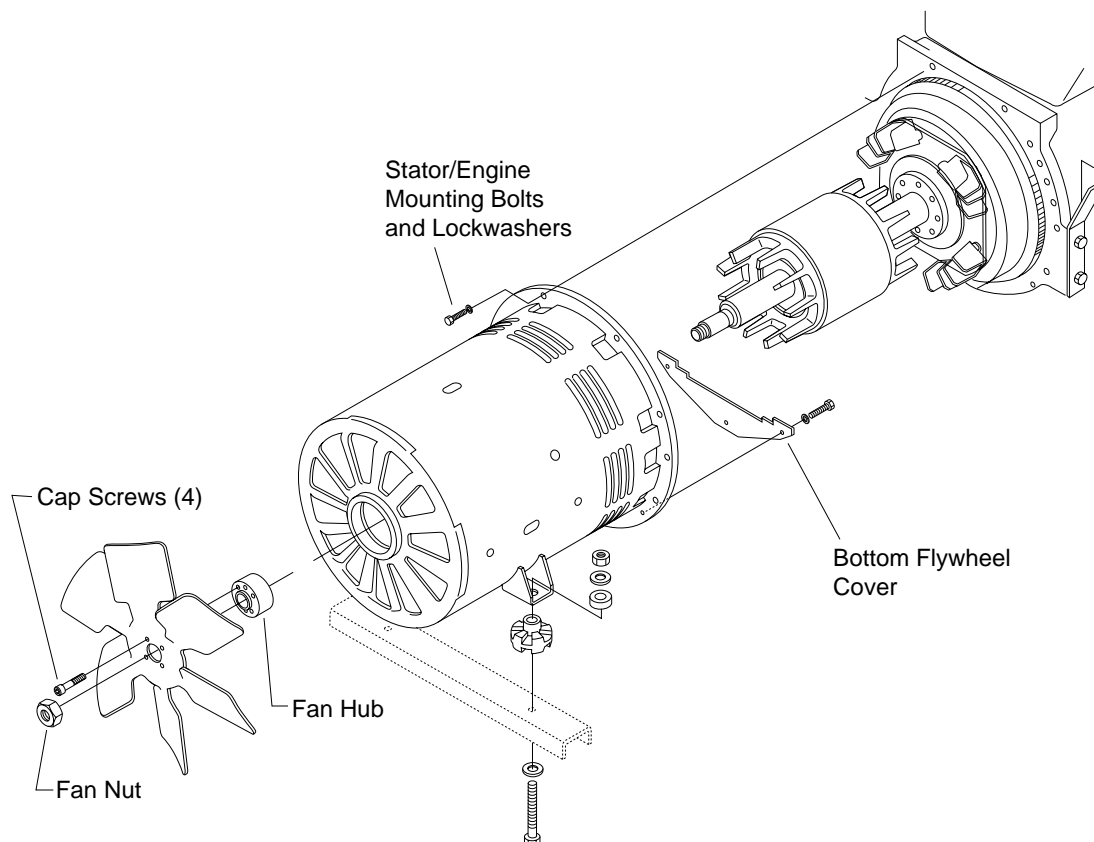
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Return to Master TOC



# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT *(continued)*

FIGURE F.61 – STATOR REMOVAL



### STATOR REMOVAL PROCEDURE

1. Using the 1/4" Allen wrench, remove the four cap screws mounting the fan blade to the hub.
2. Using the 1-13/32" socket wrench, remove the fan nut from the threaded shaft. Remove the fan blade, taking note of placement for reassembly. (Be sure not to place the fan on backwards.)
3. Using the 7/16" wrench, remove the three bolts and lock washers holding the bottom flywheel cover to the stator frame assembly. Remove the cover. See Figure F. 61.
4. Using the 11/16" wrench, remove the eight bolts and lock washers holding the stator frame to the engine. Support the stator with the hoist and make sure the engine is blocked securely. See Figure F.61.
5. Remove the stator from the engine/rotor assembly by prying and sliding the stator from the engine.

COMMANDER 400

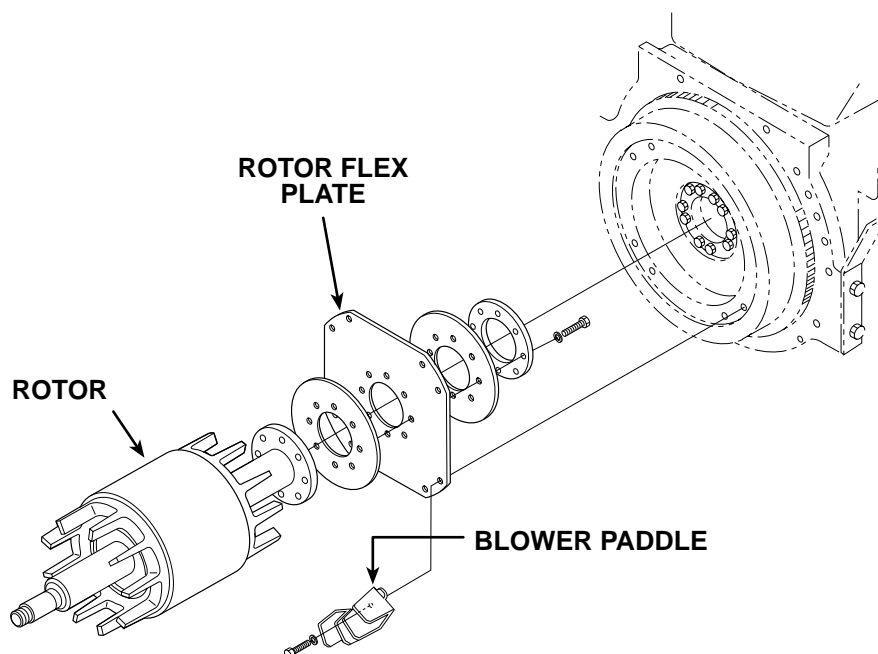




# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT (*continued*)

FIGURE F.62 – BLOWER PADDLE/FLEX PLATE REMOVAL



### ROTOR REMOVAL PROCEDURE

1. Using the 5/8" wrench, remove the blower paddles/rotor flex plate bolts and lock washers. See Figure F. 62. Support the rotor and engine securely.

#### **⚠ WARNING**

**The rotor will be free to fall when the bolts are removed.**

2. Using the hoist, carefully remove the rotor and flex plate assembly.

### REASSEMBLY NOTES

Reassemble the rotor and stator to the Commander 400 by carefully retracing the disassembly procedure steps in reverse order. Keep the following special points in mind as you proceed. Lead Reconnection Checklists are provided here as an aid to reassembly.

1. **INSTALL ROTOR:** Support the rotor with the hoist. Install the blower paddles and flex plate to the engine flywheel.
2. **INSTALL STATOR:** Be sure the engine is blocked securely and the stator is supported with the hoist. Install the stator to the engine with the eight bolts and lock washers. Install the bottom flywheel cover to the stator frame with three bolts and lock washers. Install the fan blade, making sure that it faces the proper direction, with the fan nut and four Allen head cap screws.

Check the air gap for .012" minimum.

COMMANDER 400



# TROUBLESHOOTING & REPAIR

## ENGINE, STATOR/ROTOR REMOVAL AND REPLACEMENT (*continued*)

### LEAD RECONNECTION CHECKLIST

#### Engine

- ☐ Engine grounding strap to engine
- ☐ Leads #242E and #229 to fuel level sensor
- ☐ Leads #224, #240, #225, and #262 to shut-down solenoid
- ☐ Leads #226, #237, #227, and #254 to the idler solenoid
- ☐ Leads #228 and #234 to oil pressure sensor
- ☐ Leads #233A and #241 to oil temperature sensor
- ☐ Grounding lead to top of engine bell housing
- ☐ Leads #236A, #236B, #236C, #231A and #231B to starter motor solenoid
- ☐ Leads #239, #285, and #238 to engine alternator

### SCR/Diode rectifier bridge assembly

- ☐ Stator leads W1-W4, W2-W5 and W3-W6.

### Exciter board

- ☐ Stator leads T1, T2, and T3 to studs

### Control board/box

- ☐ Plug J2
- ☐ Leads #5 and #5A to neutral T2 stud (center)
- ☐ Lead #6 to T1 stud (top) and toroid assembly (note number of turns and direction)
- ☐ Lead #3 to T3 stud (bottom) and toroid assembly (note number of turns and direction)

COMMANDER 400



# TROUBLESHOOTING & REPAIR

## RETEST AFTER REPAIR

Retest a machine:

- If it is rejected under test for any reason that requires you to remove any mechanical part which could affect the machine's electrical characteristics. OR
- If you repair or replace any electrical components.

### ENGINE OUTPUT

Mode	No Load RPM	Load RPM
Low Idle	1325 - 1400	NA
High Idle	1890 - 1915	1800

### WELDER DC (STICK) OUTPUT

Range Switch	Fine Control	Open Circuit Volts	Load Volts	Load Amps
Maximum	Maximum	70	40	500

### WELDER CV (WIRE) OUTPUT

Range Switch	Fine Control	Open Circuit Volts	Load Volts	Load Amps
Maximum	Maximum	48	40	500

### AUXILIARY POWER OUTPUT

230 Volt Receptacle			115 Volt Receptacle		
Open Circuit Voltage	Load Volts	Load Amps	Open Circuit Voltage	Load Volts	Load Amps
230 - 250	224	44.6	115 - 132	108 - 126	13 - 16

COMMANDER 400



NOTES

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Return to Master TOC	Return to Master TOC	Return to Master TOC	Return to Master TOC

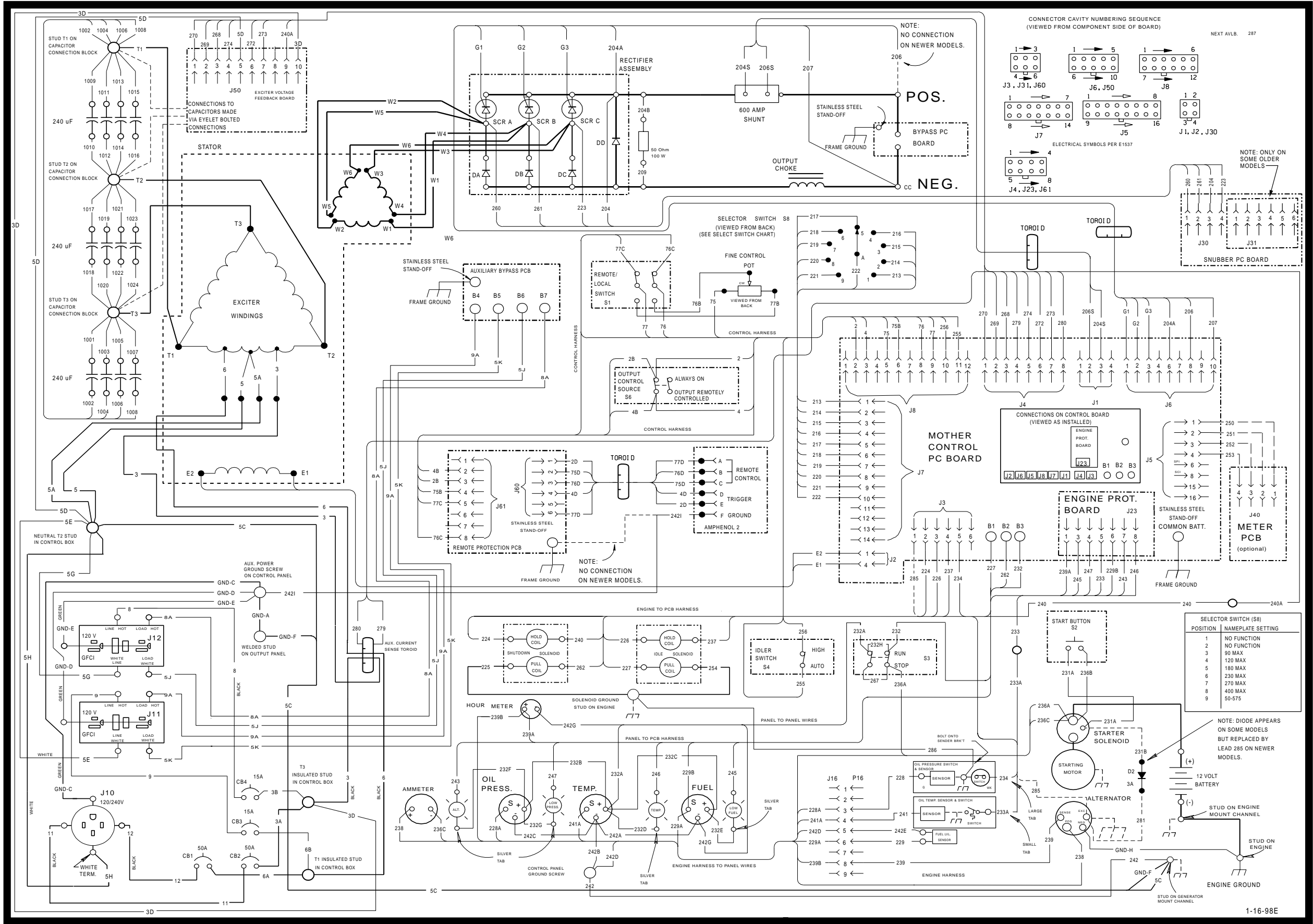


# ELECTRICAL DIAGRAMS

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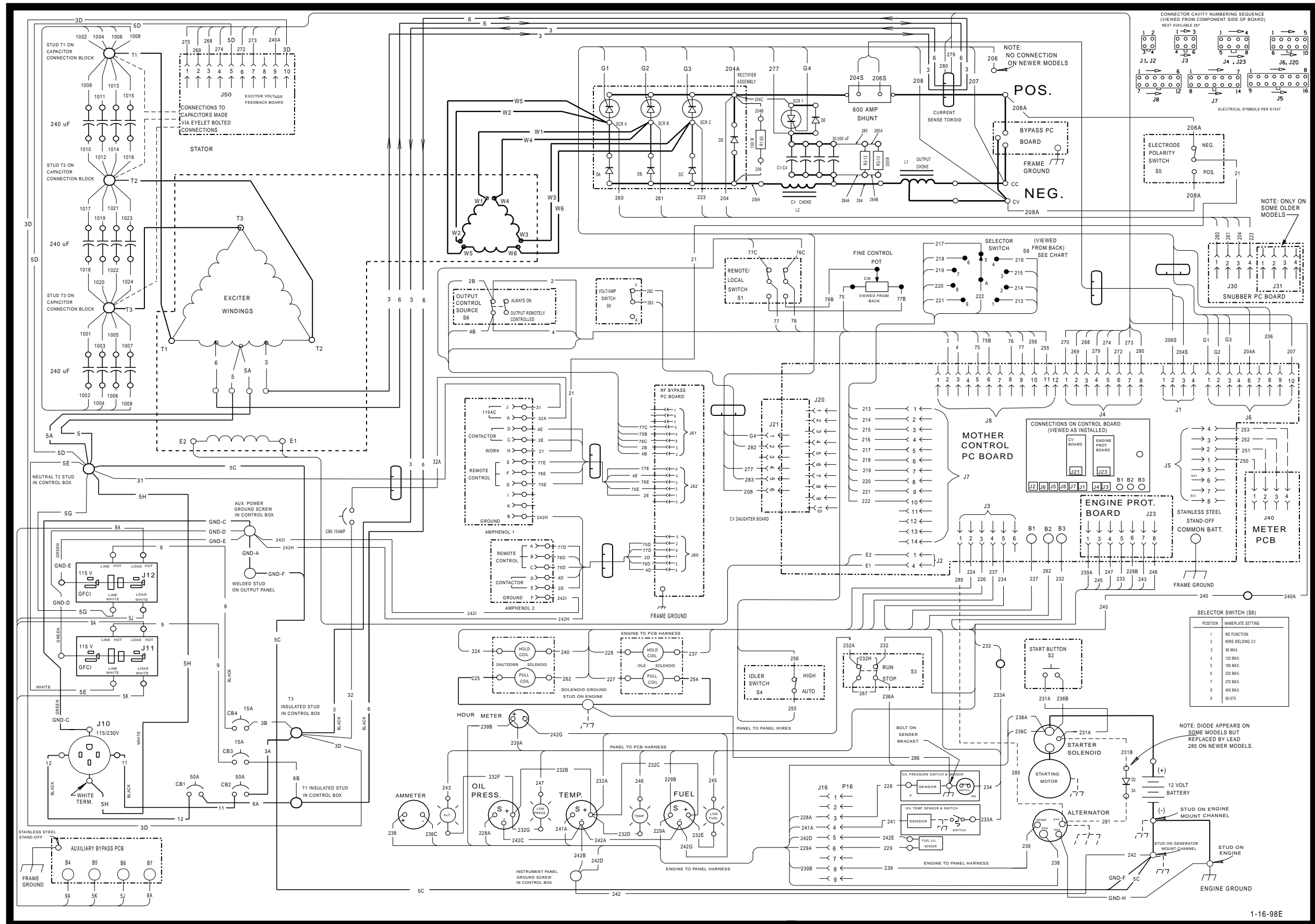
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WIRING DIAGRAM - STICK MODEL (CODE 9978)



NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual. The wiring diagram specific to your code is pasted inside one of the enclosure panels of your machine.

## WIRING DIAGRAM - STICK &amp; WIRE MODEL (CODE 9979)



L8910

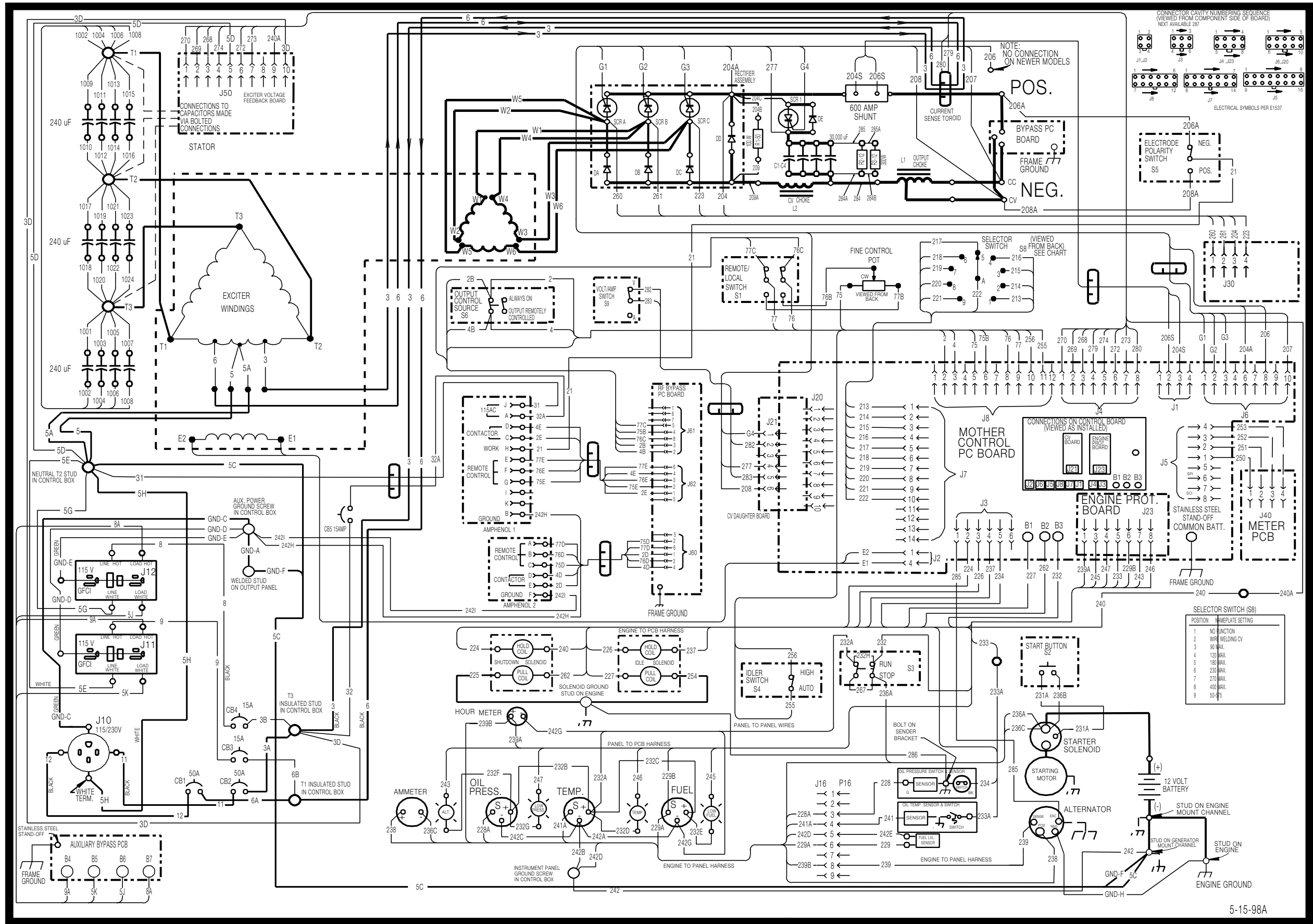
**NOTE:** This diagram is for reference only. It may not be accurate for all machines covered by this manual. The wiring diagram specific to your code is pasted inside one of the enclosure panels of your machine.





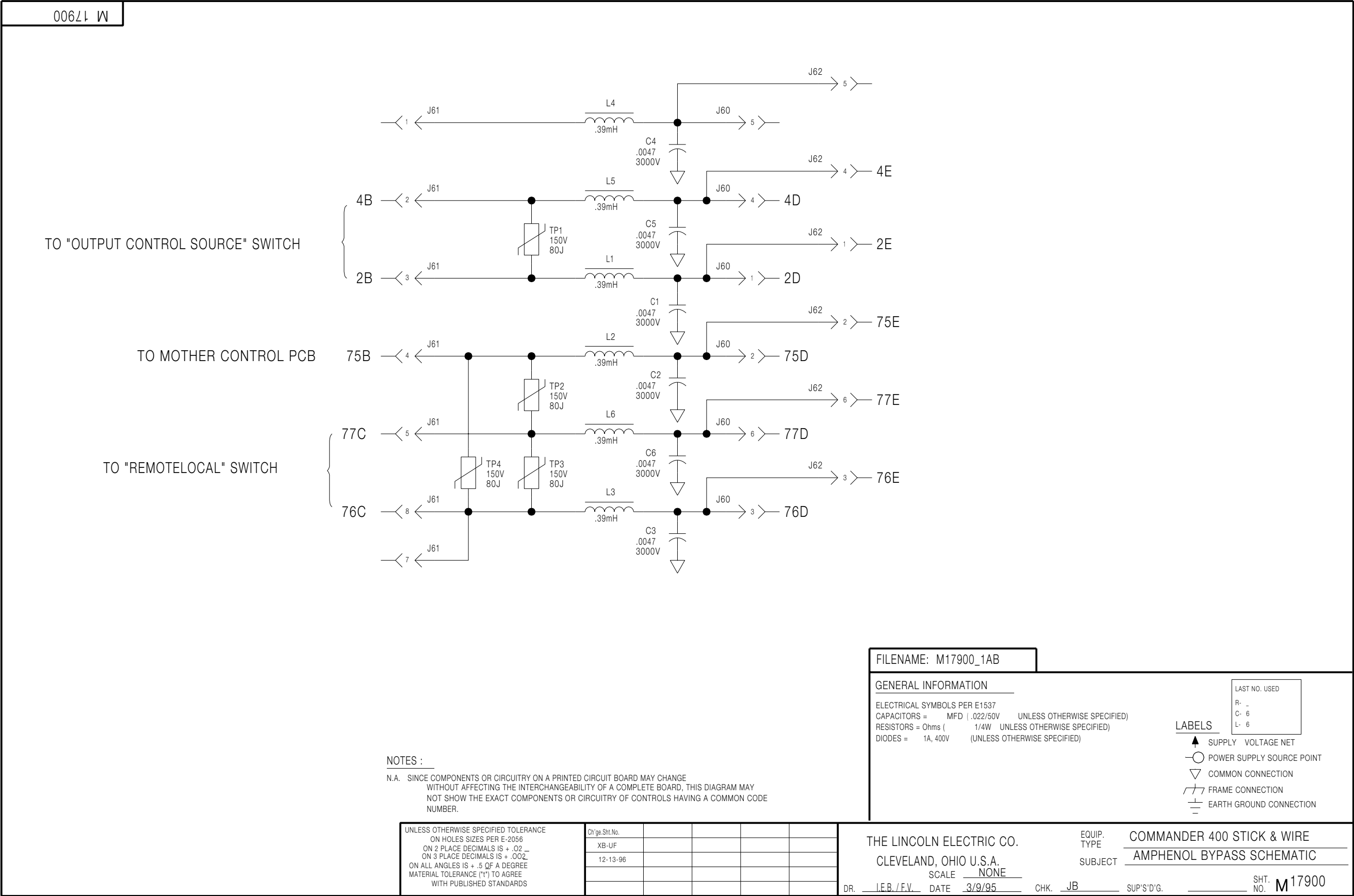


WIRING DIAGRAM - STICK & WIRE MODEL (CODE 10581)



**NOTE:** This diagram is for reference only. It may not be accurate for all machines covered by this manual. The wiring diagram specific to your code is pasted inside one of the enclosure panels of your machine.

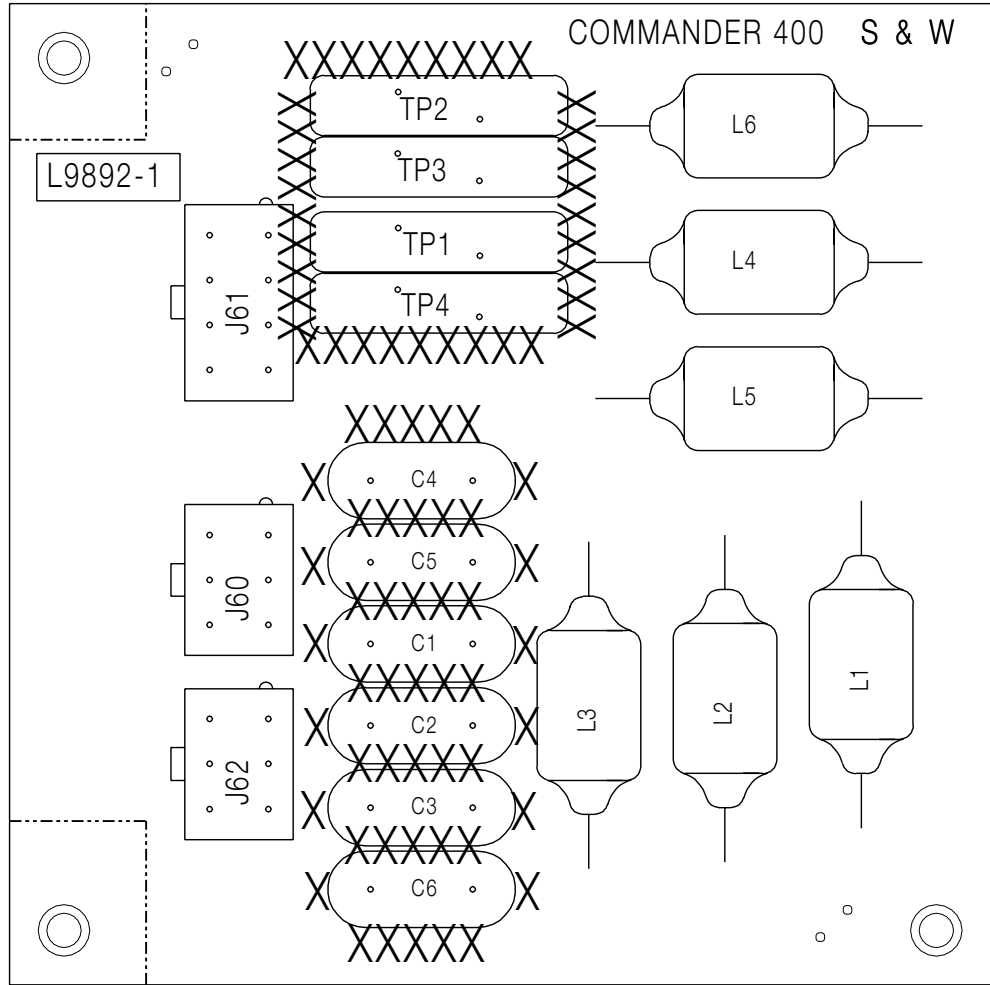
SCHEMATIC - AMPHENOL BYPASS PC BOARD



NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual.



PC BOARD ASSEMBLY - AMPHENOL BYPASS PC BOARD



ITEM	REQ'D	PART NO.	IDENTIFICATION
C1, C2, C3, C4, C5, C6	6	T11577-58	.0047/3000V
J60, J62	2	S18248-6	HEADER
J61	1	S18248-8	CONNECTOR
L1, L2, L3, L4, L5, L6	6	T12218-9	.39mH
TP1, TP2, TP3, TP4	4	T13640-16	80J

CAPACITORS = MFD/VOLTS  
INDUCTANCE = HENRYS

L9892-1  
12-13-96

SCHEMATIC - AUXILIARY PROTECTION PC BOARD

S 22111

RECEPTACLE

RECEPTACLE

HOT 1

NEUTRAL 1

NEUTRAL 2

HOT 2

FRAME

B4

B5

B6

B7

C1

C2

C3

C4

C5

C6

C7

C8

C9

C10

C11

C12

FRAME

THIS SHEET CONTAINS PROPRIETARY INFORMATION OWNED BY THE LINCOLN ELECTRIC CO. AND IS NOT TO BE REPRODUCED, DISCLOSED OR USED WITHOUT THE EXPRESS PERMISSION OF THE LINCOLN ELECTRIC CO.

NOTES :

N.A. SINCE COMPONENTS OR CIRCUITRY ON A PRINTED CIRCUIT BOARD MAY CHANGE WITHOUT AFFECTING THE INTERCHANGEABILITY OF A COMPLETE BOARD, THIS DIAGRAM MAY NOT SHOW THE EXACT COMPONENTS OR CIRCUITRY OF CONTROLS HAVING A COMMON CODE NUMBER.

GENERAL INFORMATION

ELECTRICAL SYMBOLS PER E1537

CAPACITORS = MFD (.0047/1400V UNLESS OTHERWISE SPECIFIED)

RESISTORS = Ohms ( 1/4W UNLESS OTHERWISE SPECIFIED)

DIODES = 1A, 400V (UNLESS OTHERWISE SPECIFIED)

LABELS

▲ SUPPLY VOLTAGE NET

○ POWER SUPPLY SOURCE POINT

▽ COMMON CONNECTION

▤ FRAME CONNECTION

⊥ EARTH GROUND CONNECTION

FILE: S22111\_1AA

UNLESS OTHERWISE SPECIFIED TOLERANCE

ON HOLES SIZES PER E-2056

ON 2 PLACE DECIMALS IS + .02

ON 3 PLACE DECIMALS IS + .002

ON ALL ANGLES IS + .5 OF A DEGREE

MATERIAL TOLERANCE ("t") TO AGREE WITH PUBLISHED STANDARDS

Ch'ge.	Sht.	No.			
XA					
12-15-95					

THE LINCOLN ELECTRIC CO.

CLEVELAND, OHIO U.S.A.

SCALE NONE

DR. B.K. DATE 12-29-94 CHK. FV SUP'S'D'G. \_\_\_\_\_

EQUIP. TYPE

COMMANDER 400

SUBJECT

AUX. PROTECTION P.C. BD. SCHEMATIC

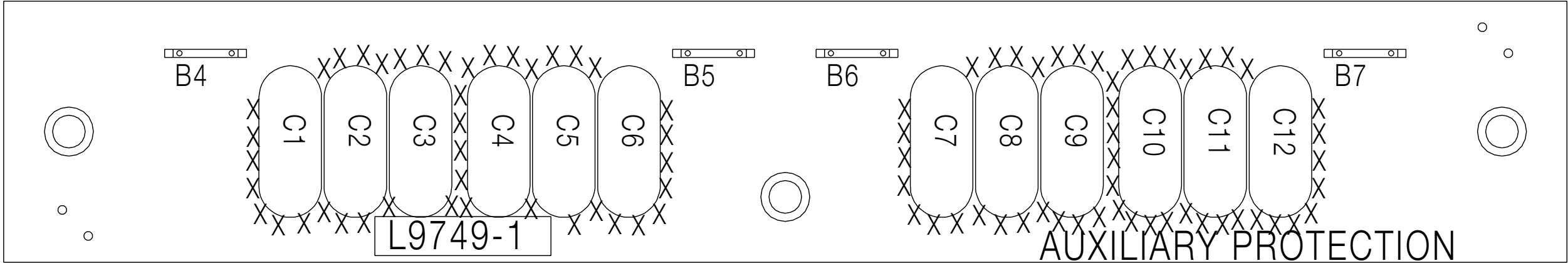
SHT. NO.

S 22111

NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual.



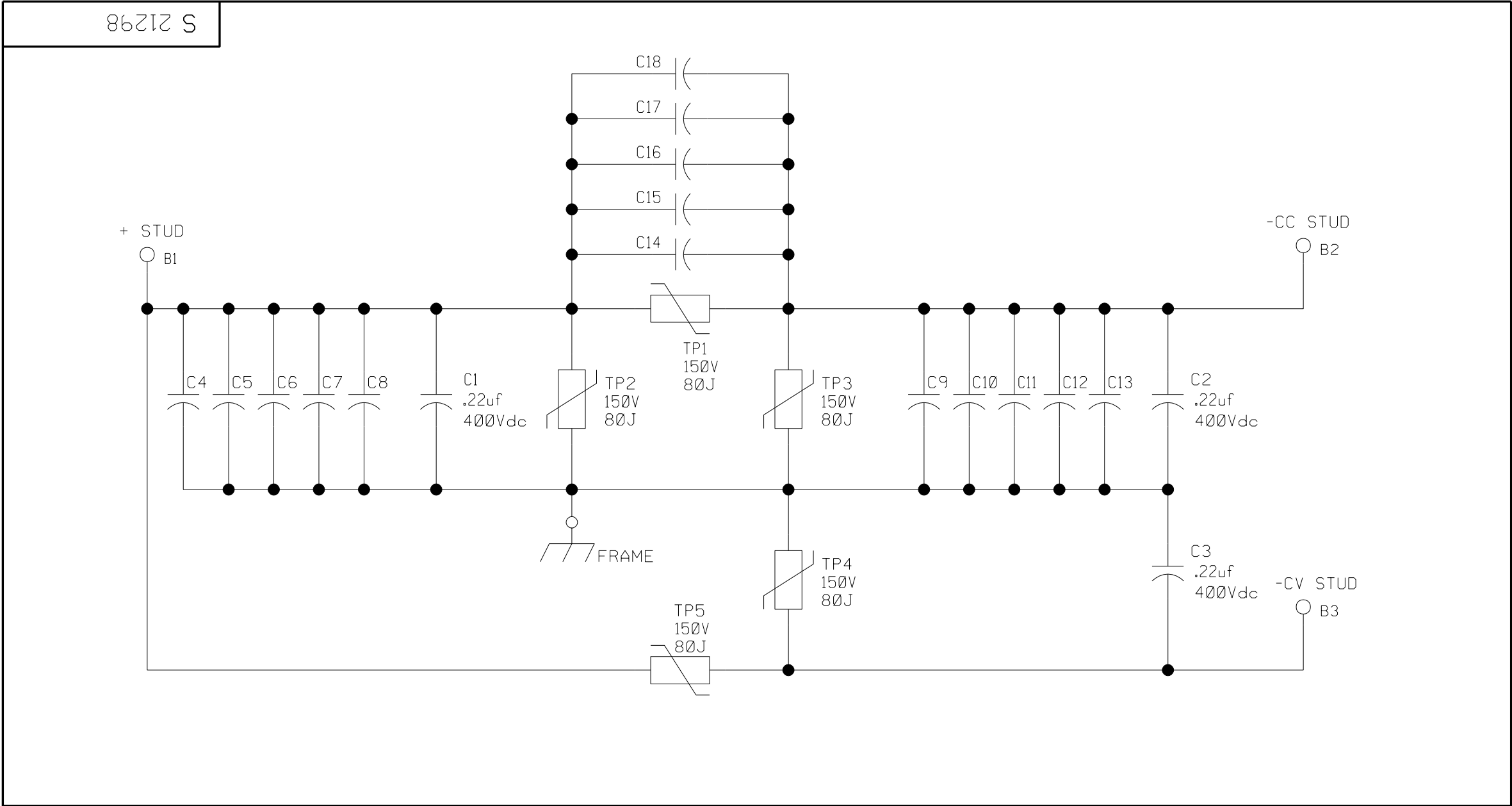
PC BOARD ASSEMBLY - AUXILIARY PROTECTION PC BOARD



ITEM	REQ'D	PART NO.	DESCRIPTION
B 4, B 5, B 6, B 7	4	T 13 157 - 14	TAB TERMINAL
C 1, C 2, C 3, C 4, C 5, C 6, C 7, C 8, C 9 C 10, C 1 1, C 12	12	T 1 1577 - 52	. 0047 or . 005 / 1400

L9749-1  
12-15-95A

SCHEMATIC - BYPASS PC BOARD



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NOTES :

N.A. SINCE COMPONENTS OR CIRCUITRY ON A PRINTED CIRCUIT BOARD MAY CHANGE WITHOUT AFFECTING THE INTERCHANGEABILITY OF A COMPLETE BOARD, THIS DIAGRAM MAY NOT SHOW THE EXACT COMPONENTS OR CIRCUITRY OF CONTROLS HAVING A COMMON CODE NUMBER.

GENERAL INFORMATION

ELECTRICAL SYMBOLS PER E1537  
CAPACITORS = MFD ( .0047/1400V UNLESS OTHERWISE SPECIFIED)  
RESISTORS = Ohms ( 1/4W UNLESS OTHERWISE SPECIFIED)  
DIODES = 1A, 400V (UNLESS OTHERWISE SPECIFIED)

LABELS

- SUPPLY VOLTAGE NET
- POWER SUPPLY SOURCE POINT
- COMMON CONNECTION
- FRAME CONNECTION
- EARTH GROUND CONNECTION

FILE: S21298\_1AD

UNLESS OTHERWISE SPECIFIED TOLERANCE  
ON HOLES SIZES PER E-2056  
ON 2 PLACE DECIMALS IS\_+ .02  
ON 3 PLACE DECIMALS IS\_+ .002  
ON ALL ANGLES IS\_+ .5 OF A DEGREE  
MATERIAL TOLERANCE ("t") TO AGREE  
WITH PUBLISHED STANDARDS

Ch'ge.Sht.No.				
XA				
12-15-95				

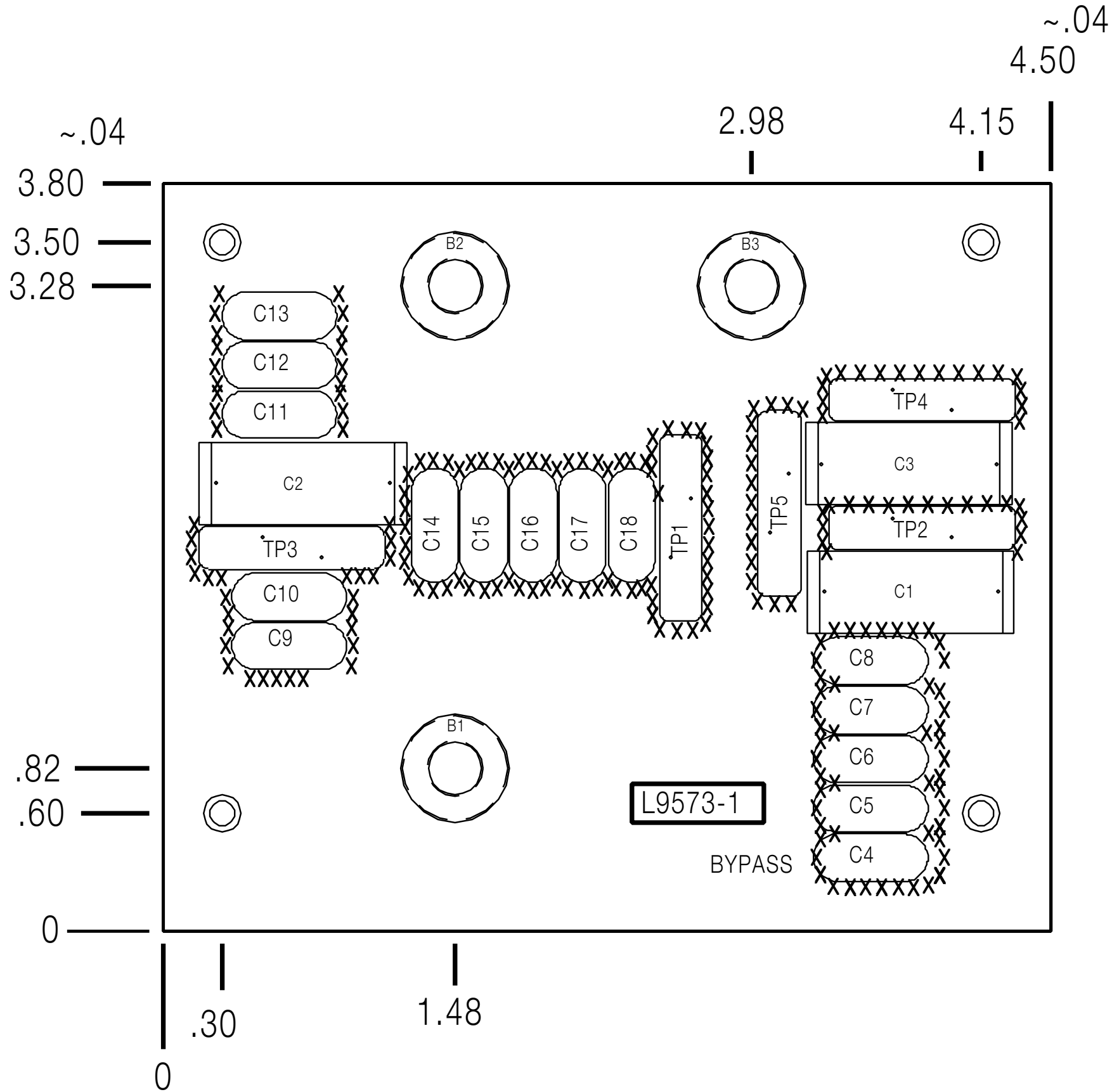
THE LINCOLN ELECTRIC CO.  
CLEVELAND, OHIO U.S.A.  
SCALE NONE  
DR. B.K. DATE 02-03-94 CHK. FV SUP'S'D'G.

EQUIP. TYPE  
COMMANDER 400  
SUBJECT  
BYPASS P.C. BD. SCHEMATIC

SHT. NO.  
S 21298

NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual.

PC BOARD ASSEMBLY - BYPASS PC BOARD



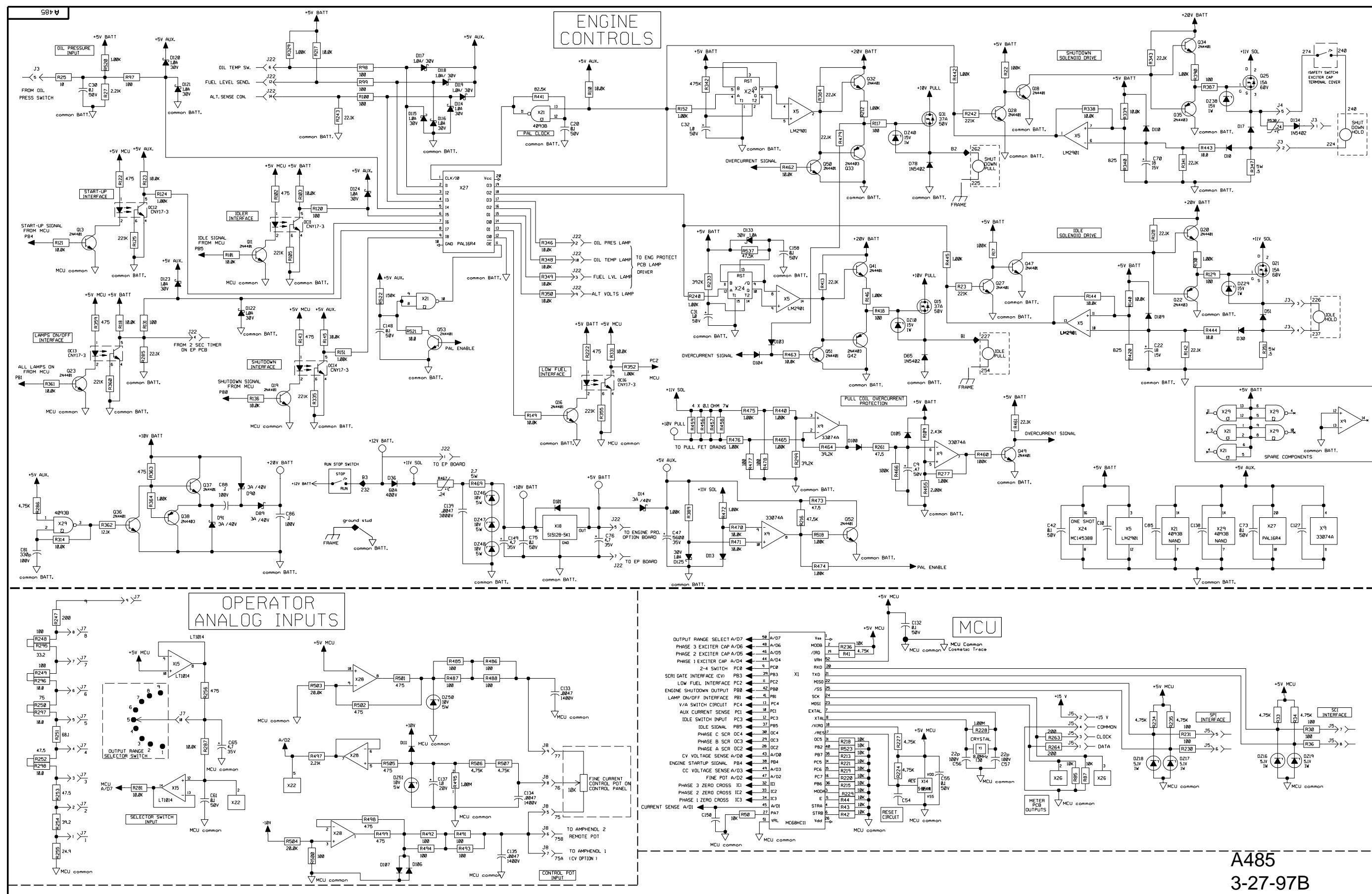
ITEM	REQ'D	PART NO.	IDENTIFICATION
C1,C2,C3	3	S20500-3	.22/400V
C4,C5,C6,C7,C8,C9,C10,C11 C12,C13,C14,C15,C16,C17,C18	15	T11577-52	.0047 or .005/1400
TP1,TP2,TP3,TP4,TP5	5	T13640-16	80J

CAPACITORS = MFD/VOLTS  
INDUCTANCE = HENRYS

L9573-1  
10-11-96B



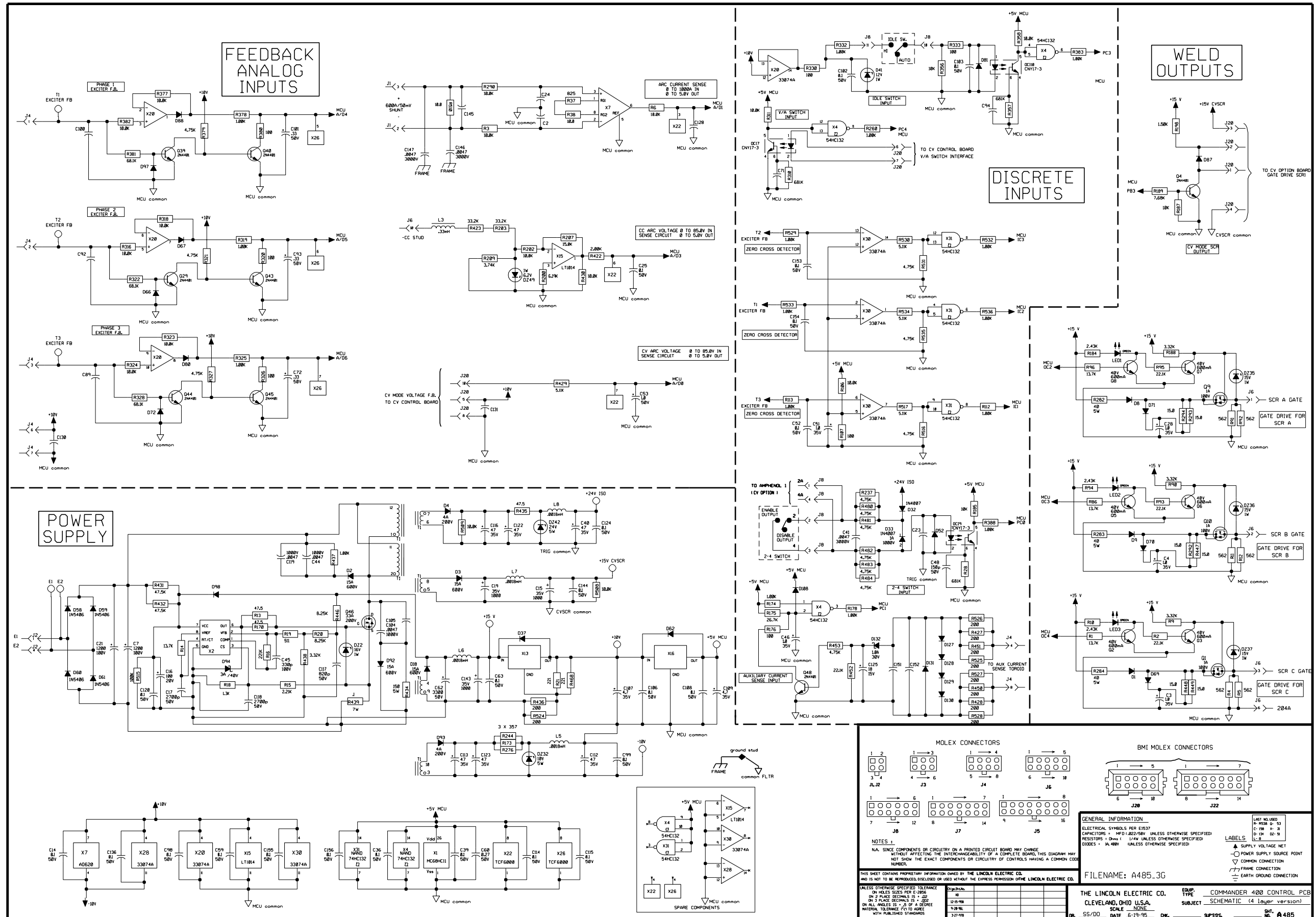
## SCHEMATIC - CONTROL PC BOARD PART 1



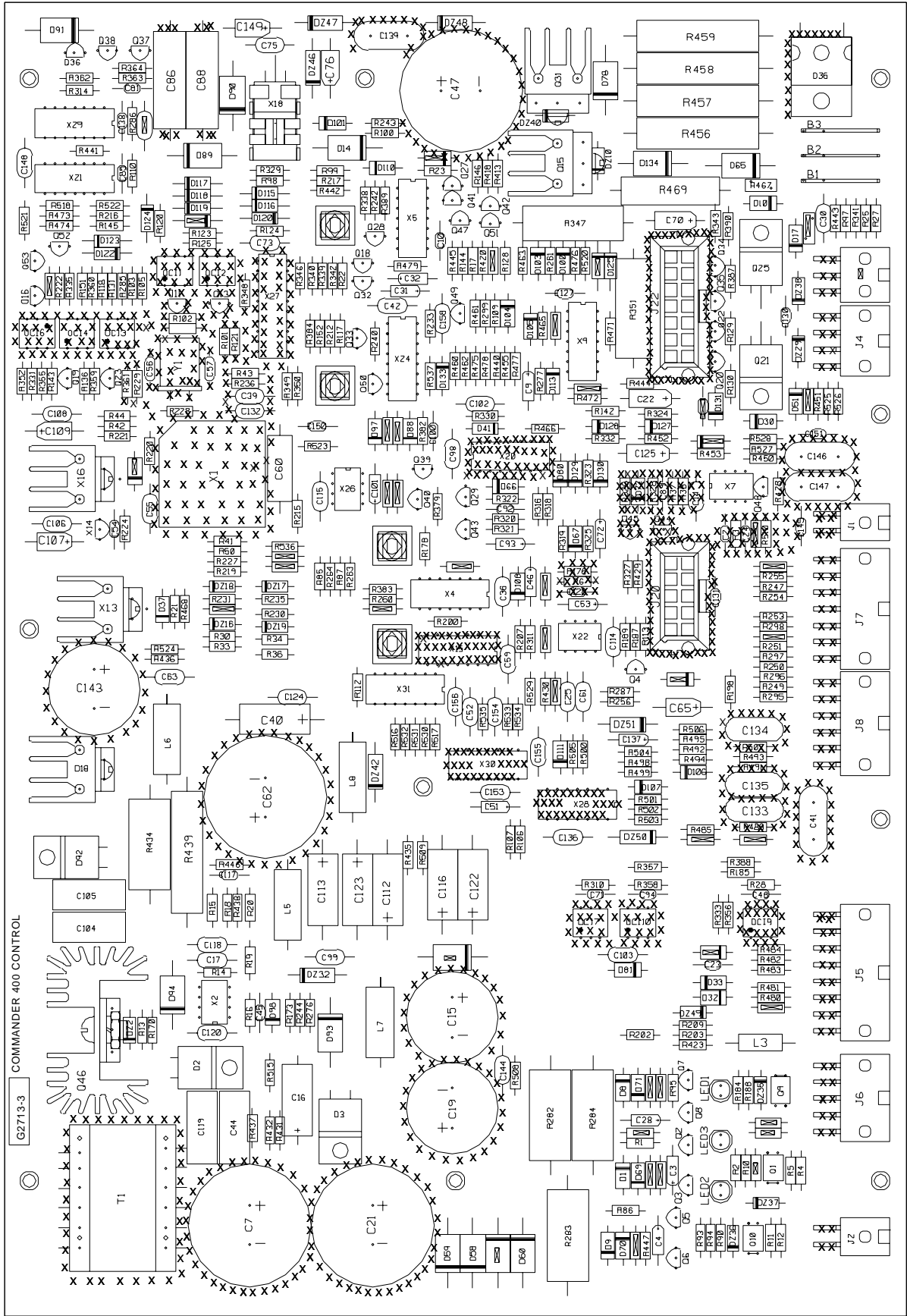
NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual.



## SCHEMATIC - CONTROL PC BOARD PART 2



PC BOARD ASSEMBLY - CONTROL PC BOARD



ITEM	REQ'D	PART NO.	IDENTIFICATION
B1, B2, B3	3	T13157-16	RT ANGLE TAB
C2, C10, C23, C24, C54, C71, C85, C89, C92, C94, C100, C127, C128, C130, C131, C138, C145, C150, C151, C152	20	S16668-5	.022/50
C3, C4, C28, C46, C51	5	S13490-42	1.0/35
C7, C21	2	S13490-138	1200/100
C9	1	S13490-63	.47/50
C14, C20, C25, C30, C36, C39, C42, C52, C55, C59, C61, C63, C73, C75, C98, C99, C102, C103, C106, C108, C114, C115, C120, C124, C132, C136, C144, C148, C153, C154, C155, C156, C158	33	S16668-11	.1/50
C15, C19, C143	3	S13490-121	1000/35
C16	1	S13490-97	100/20
C17, C118	2	S16668-4	2700pF/50
C22, C70, C125	3	S13490-39	18/15
C31, C32, C53	3	S13490-135	1.0/50V
C40, C112, C113, C116, C122, C123	6	S13490-66	47/35
C41, C139, C146, C147	4	T11877-58	.0047/3000V
C44, C104, C105, C119	4	S20500-4	.0047/1000V
C45, C81	2	S16668-8	330pF/100
C47	1	S13490-107	5600/35V
C48	1	S16668-9	150pF/100
C56, C57	2	S16668-1	22pF/100
C60	1	S13490-85	.27/50
C62	1	S13490-92	3300/50
C65, C76, C107, C109, C149	5	S13490-25	4.7/35
C72, C93, C101	3	S13490-95	.33/50
C86, C88	2	T11577-26	.1/100
C117	1	S16668-7	820pF/50
C133, C134, C135	3	T11577-52	.0047 or .005/1400
C137	1	S13490-19	1.8/20
D1, D8, D9, D10, D17, D30, D37, D51, D52, D62, D66, D67, D69, D70, D71, D72, D80, D81, D87, D88, D97, D98, D100, D101, D103, D104, D105, D106, D107, D108, D109, D110, D111, D113, D127, D128, D129, D130, D131	39	T12199-1	IN4004
D2, D3, D92	3	T12705-32	15A/600V
D4, D93	2	T12705-47	4A/200V
D14, D89, D90, D91, D94	5	T12705-37	IN5622 SCHOTTKY BARRIER DIODE
D18	1	S18395-14	DIODE HS ASBLY
D32, D33	2	T12199-2	IN4007
D36	1	T12705-52	DIODE, T218, 60A, 400V, FR
D41	1	T12702-19	IN4742A
D58, D59, D60, D61	4	T12705-29	DIODE
D65, D78, D134	3	T12705-14	DIODE
D114, D115, D116, D117, D118, D119, D120, D121, D122, D123, D124, D125, D132, D133	14	T12705-23	IN5818
DZ2	1	T12702-11	IN4745A
DZ10, DZ29, DZ35, DZ36, DZ37, DZ38, DZ40	7	T12702-29	IN4744A
DZ16, DZ17, DZ18, DZ19	4	T12702-52	IN4733A
DZ32, DZ46, DZ47, DZ48, DZ50, DZ51	6	T12702-33	IN5347B
DZ42	1	T12702-41	IN5359B ZENER DIODE
DZ49	1	T12702-40	IN4735
J1, J2	2	S20351-4	HEADER
J3	1	S20351-6	HEADER
J4	1	S20351-8	HEADER
J5	1	S20351-16	HEADER
J6	1	S20351-10	RT. ANGLE HEADER
J7	1	S20351-14	HEADER
J8	1	S20351-12	HEADER
J20	1	S21134-10	MOLEX CONNECTOR
J22	1	S21134-14	MOLEX CONNECTOR
L3	1	T12218-7	330uH
L5, L6, L7, L8	4	T12218-13	CHOKE, 1.8uH, 15%, 4.6A
LED1, LED2, LED3	3	T13657-3	GREEN LED
OC1, OC2, OC3, OC4, OC16, OC17, OC19, OC110	8	S15000-10	OPTO ISOLATOR
Q1, Q9, Q10	3	T12704-73	IC PKG MOSFET (SS)
Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q11, Q13, Q16, Q18, Q19, Q20, Q23, Q27, Q28, Q29, Q32, Q34, Q36, Q37, Q39, Q40, Q41, Q43, Q44, Q45, Q47, Q48, Q49, Q50, Q51, Q52, Q53	34	T12704-68	2N4401
Q15, Q31	2	S18395-16	H. S. ASBLY (SS)
Q21, Q25	2	T12704-54	N-CHANNEL FET (SS)
Q22, Q33, Q35, Q38, Q42	5	T12704-69	2N4403
Q46	1	S20106-1	HEXFET W/ H. S. ASBLY (SS)
R1, R14, R85, R96	4	S19400-1372	13.7K 1/4W
R2, R93, R95, R128, R142, R243, R285, R341, R343, R384, R413, R452, R461, R479	14	S19400-2212	22.1K 1/4W
R3, R6, R42, R43, R44, R50, R85, R87, R101	61	S19400-1002	10K 1/4W
R103, R106, R110, R118, R121, R123, R136, R140, R144, R145, R149, R185, R187, R202, R213, R215, R217, R218, R219, R220			

CAPACITORS = MFD/VOLTS  
RESISTORS = OHMS

ITEM	REQ'D	PART NO.	IDENTIFICATION
R221, R229, R236, R281, R287, R290, R311, R314, R316, R318, R323, R324, R331, R338, R339, R346, R348, R349, R350, R356, R358, R361, R377, R382, R430, R462, R463, R470, R471, R508, R509, R523			
R4, R5, R11, R12, R91, R92	6	S19400-5620	562 1/4W
R9, R90, R188, R438	4	S19400-3321	3.32K 1/4W
R10, R94, R109, R184	4	S19400-2431	2.43K 1/4W
R13, R170, R252, R253, R261, R435, R473	7	S19400-47R5	47.5 1/4W
R15, R27, R497	3	S19400-2211	2.21K 1/4W
R16, R23, R105, R125, R242, R335, R355, R360	8	S19400-2213	221K 1/4W
R17, R22, R460, R466, R515	5	S19400-1003	100K 1/4W
R18	1	S19400-1301	1.3K 1/4W
R19	1	S19400-5110	511 1/4W
R20, R446	2	S19400-8251	8.25K 1/4W
R21, R468	2	S19400-2210	221 1/4W
R25, R38, R296, R297, R298, R443, R444, R510, R521	9	S19400-10R0	10 1/4W
R28, R310, R357	3	S19400-6813	681K 1/4W
R30, R36, R97, R98, R99, R100, R107, R117, R120, R129, R131, R176, R230, R231, R248, R249, R320, R326, R330, R333, R380, R387, R418, R477, R478, R485, R486, R487, R488, R491, R492, R493, R494, R500	34	S19400-1000	100 1/4W
R33, R34, R41, R224, R227, R234, R235, R237, R286, R321, R327, R379, R453, R480, R481, R482, R483, R484, R506, R507, R516, R531, R535	23	S19400-4751	4.75K
R37, R340, R420	3	S19400-8250	825 1/4W
R102, R122, R143, R222, R256, R359, R363, R498, R499, R501, R502, R505	12	S19400-4750	475 1/4W
R112, R113, R124, R130, R146, R151, R152, R174, R178, R212, R240, R260, R277, R319, R325, R329, R332, R352, R364, R378, R383, R388, R389, R390, R437, R440, R442, R445, R465, R472, R474, R475, R476, R518, R520, R529, R532, R533, R536	39	S19400-1001	1K 1/4W
R173, R244, R276	3	S19400-3570	357 1/4W
R175	1	S19400-2672	26.7K 1/4W
R189	1	S19400-7681	7.68K 1/4W
R198	1	S19400-1501	1.5K 1/4W
R200	1	S19400-6191	6.19K 1/4W
R203, R423	2	S19400-3322	33.2K 1/4W
R207	1	S19400-1502	15K 1/4W
R209	1	S19400-3741	3.74K 1/4W
R216, R431, R432, R537	4	S19400-4752	47.5K 1/4W
R228, R495	2	S19400-1004	1M 1/4W
R233	1	S19400-3923	392K 1/4W
R247, R263, R264, R427, R428, R436, R450, R451, R524, R525, R526, R527, R528	13	S19400-2000	200 1/4W
R250	1	S19400-75R0	75 1/4W
R251	1	S19400-68R1	68.1 1/4W
R254	1	S19400-39R2	39.2 1/4W
R255	1	S19400-24R9	24.9 1/4W
R282, R283, R284	3	T14648-4	5W, .40 OHM RESISTOR
R292, R293, R294, R447, R448, R449	6	S19400-15R0	15 1/4W
R295	1	S19400-33R2	33.2 1/4W
R299, R464	2	S19400-3922	39.2K 1/4W
R322, R328, R381	3	S19400-6812	68.1K 1/4W
R342	1	S19400-4753	475K 1/4W
R347, R351	2	T12300-81	5 WATT 0.5+/-1% OHM RESISTOR
R362	1	S19400-1212	12.1K 1/4W
R422, R455	2	S19400-2001	2.0K 1/4W
R434	1	T14648-20	150 OHM 5 WATT RESISTOR
R439, R456, R457, R458, R459	5	T12300-77	0.1 OHMS/7WATT WIRE WOUND
R441	1	S19400-8252	82.5K 1/4W
R467, R538	2	S18380-5	PTC THERMISTOR
R469	1	T13165-11	2.7 OHM, 5 WATT RESISTOR
R503, R504	2	S19400-2002	20K 1/4W
R429, R517, R530, R534	4	S19400-5111	5.11K 1/4W
R522	1	S19400-1503	150K 1/4W
T1	1	S20375-3	TRANSFORMER, PCB, PWM
X1	1	S22119-8	(SSI) ROM ASSEMBLY
X2	1	M15458-4	8 PIN IC
X4, X31	2	S17900-24	QUAD 2-INPUT SCHMITT TRIG. NAND (SSI)
X5	1	S15128-11	14 PIN QUAD COMPARATOR
X7	1	S15128-20	AMPLIFIER
X9, X20, X28, X30	4	S15128-18	QUAD-OP AMP
X13, X16	2	S18395-3	HEAT SINK ASBLY
X14	1	M15102-3	RESET I.C. UNDERVOLT. SENSING CIR. (SSI)
X15	1	S15128-16	LINEAR INTEGRATED CIRCUIT
X18	1	S15128-5	+5V REG.
X21, X29	2	S15018-15	14 PIN I.C. (SSI)
X22, X26	2	S15018-18	IC, ARRAY, CLAMPING
X24	1	S15018-9	CMOS MC14538B (SSI)
X27	1	S22019-1	IC, CMOS, PLD, (SSI)
Y1	1	S16665-5	8.0 MHZ

G2713-3  
10-22-99B

**GENERAL INFORMATION**

ELECTRICAL SYMBOLS PER E1537  
 CAPACITORS = MFD (.022/50V UNLESS OTHERWISE SPECIFIED)  
 RESISTORS = Ohms ( 1/4W UNLESS OTHERWISE SPECIFIED)  
 DIODES = 1A, 400V (UNLESS OTHERWISE SPECIFIED)

**NOTES :**

N.A. SINCE COMPONENTS OR CIRCUITRY ON A PRINTED CIRCUIT BOARD MAY CHANGE WITHOUT AFFECTING THE INTERCHANGEABILITY OF A COMPLETE BOARD, THIS DIAGRAM MAY NOT SHOW THE EXACT COMPONENTS OR CIRCUITRY OF CONTROLS HAVING A COMMON CODE NUMBER.

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UNLESS OTHERWISE SPECIFIED TOLERANCE  
 ON HOLES SIZES PER E-2056  
 ON 2 PLACE DECIMALS IS + .02 -  
 ON 3 PLACE DECIMALS IS + .002 -  
 ON ALL ANGLES IS + .5 OF A DEGREE  
 MATERIAL TOLERANCE ("I") TO AGREE WITH PUBLISHED STANDARDS

LAST CHANGE  
 XA  
 12-13-96

THE LINCOLN ELECTRIC CO.  
 CLEVELAND, OHIO U.S.A.  
 SCALE NONE  
 DR. I.E.B./JB DATE 9/14/94 CHK. BS

EQUIP. TYPE  
 SUBJECT COMMANDER 400 S & W  
 CV CONTROL PC BRD SCHEMATIC

SHT. NO. M 17741

**FILE: M17741\_1AE**

**LAST NO. USED**  
 R- 19  
 C- 5  
 D- 3

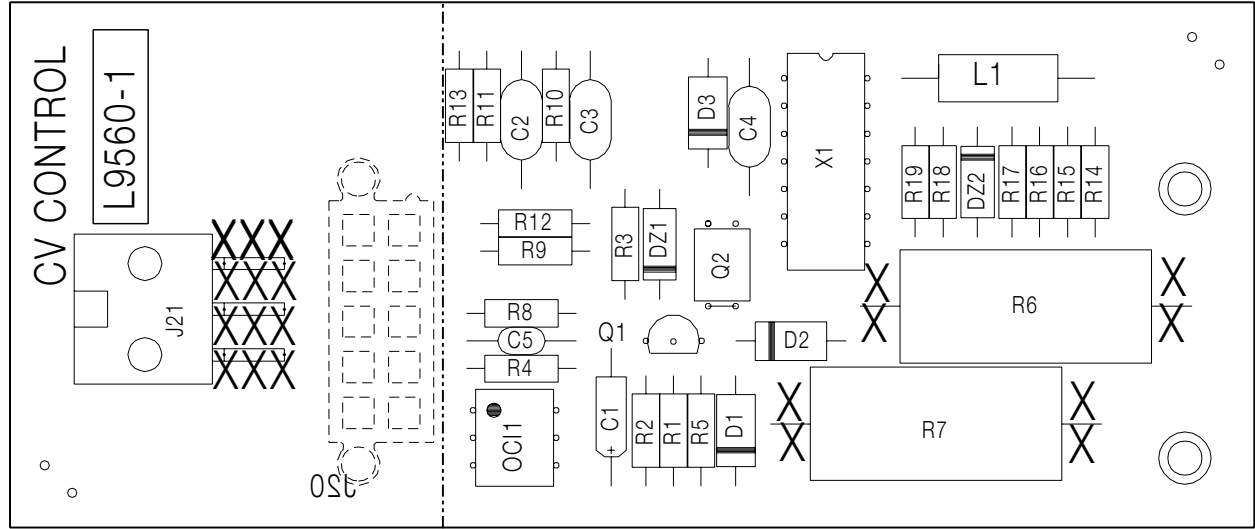
**LABELS**

▲ SUPPLY VOLTAGE NET  
 ○ POWER SUPPLY SOURCE POINT  
 ▽ COMMON CONNECTION  
 ▬ FRAME CONNECTION  
 ≡ EARTH GROUND CONNECTION



COMMANDER 400

PC BOARD ASSEMBLY - CV CONTROL PC BOARD



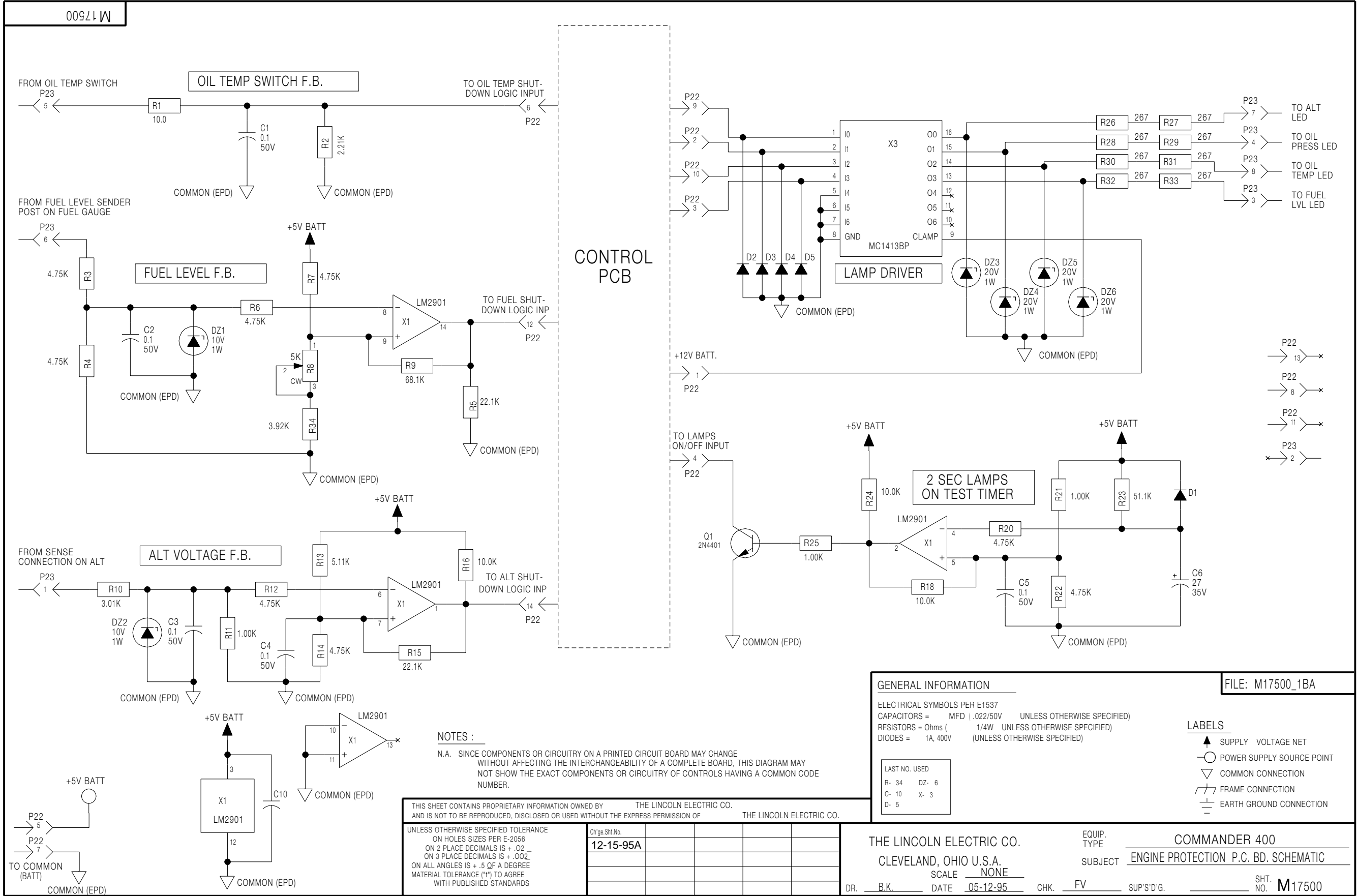
ITEM	REQ'D	PART NO.	DESCRIPTION
C 1	1	S 13490- 19	1. 8/20
C2, C3, C4	3	S 16668- 11	. 1/50
C5	1	S 16668-5	. 022/50
D 1, D2, D3	3	T 12 199- 1	1N4004
DZ 1	1	T 12702-29	1N4744A
DZ2	1	T 12702- 27	1N4740
J20	1	S2 1 135- 10	MOLEX CONNECTOR
J2 1	1	S2035 1-6	HEADER
L 1	1	T 122 18-7	330uH
OCI 1	1	S 15000- 10	OPTO ISOLATOR
Q 1	1	T 12704-68	2N440 1
Q2	1	T 12704-73	I C PKG MOSFET ( SS)
R 1	1	S 19400- 332 1	3. 32K 1/4W
R2, R 13, R 15	3	S 19400- 1002	10K 1/4W
R3, R 11	2	S 19400- 100 1	1K 1/4W
R4	1	S 19400-4753	475K 1/4W
R5	1	S 19400- 10R0	10 1/4W
R6, R7	2	T 14648- 18	68 5W
R8, R9	2	S 19400-5620	562 1/4W
R 10, R 12	2	S 19400- 1000	100 1/4W
R 14	1	S 19400- 1502	15K 1/4W
R 16	1	S 19400-6 19 1	6. 19K 1/4W
R 17	1	S 19400-68 1 1	6. 8 1K 1/4W
R 18	1	S 19400-2672	26. 7K 1/4W
R 19	1	S 19400-2802	28. 0K 1/4W
X 1	1	S 15 128- 18	QUAD-OP AMP

CAPACITORS = MFD/VOLTS  
RESISTORS = OHMS

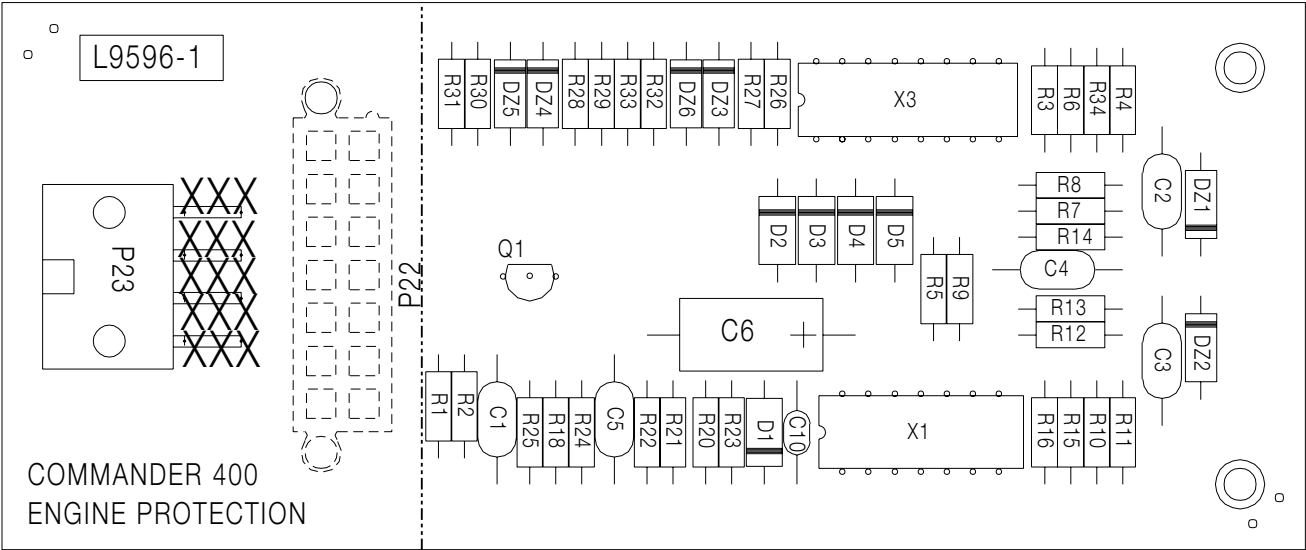
L9560  
12-13-96



SCHEMATIC - ENGINE PROTECTION PC BOARD



PC BOARD ASSEMBLY - ENGINE PROTECTION PC BOARD

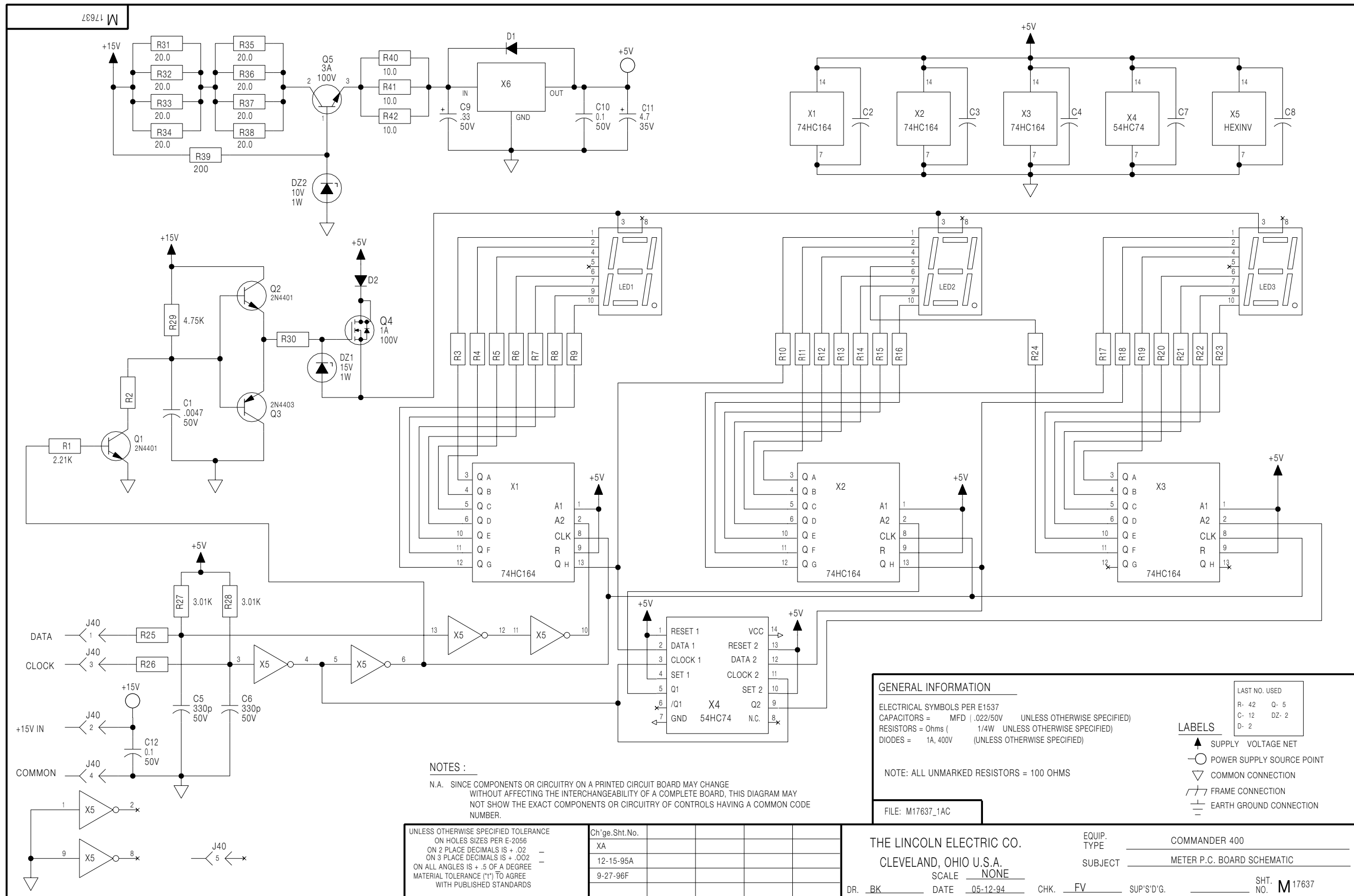


ITEM	REQ'D	PART NO.	DESCRIPTION
C 1, C2, C3, C4, C5	5	S 16668- 11	. 1/50
C6	1	S 13490-93	27/35
C 10	1	S 16668-5	. 022/50
D 1, D2, D3, D4, D5	5	T 12 199- 1	1N4004
DZ 1, DZ2	2	T 12702-27	1N4740
DZ3, DZ4, DZ5, DZ6	4	T 12702-4	1N4747
P22	1	S2 1135- 14	MOLEX CONNECTOR
P23	1	S2035 1-8	HEADER
Q 1	1	T 12704-68	2N440 1
R 1	1	S 19400- 10R0	10 1/4W
R2	1	S 19400-22 11	2. 2 1K 1/4W
R3, R4, R6, R7, R 12, R 14, R20 R22, R34	9	S 19400-475 1	4. 75K
R5, R 15	2	S 19400-22 12	22. 1K 1/4W
R8	1	S 19400-4750	475 1/4W
R9	1	S 19400-68 12	68. 1K 1/4W
R 10	1	S 19400-30 11	3. 0 1K 1/4W
R 11, R2 1, R25	3	S 19400- 100 1	1K 1/4W
R 13	1	S 19400-5 1 11	5. 11K 1/4W
R 16, R 18, R24	3	S 19400- 1002	10K 1/4W
R23	1	S 19400-5 1 12	51. 1K 1/4W
R26, R27, R28, R29, R30, R3 1 R32, R33	8	S 19400-2670	267 1/4W
X 1	1	S 15 128- 11	14 PIN QUAD COMPARATOR
X3	1	M15 102- 4	PERRIPHERAL DRIVER ARRAYS ( SS)

CAPACITORS = MFD/VOLTS  
RESISTORS = OHMS

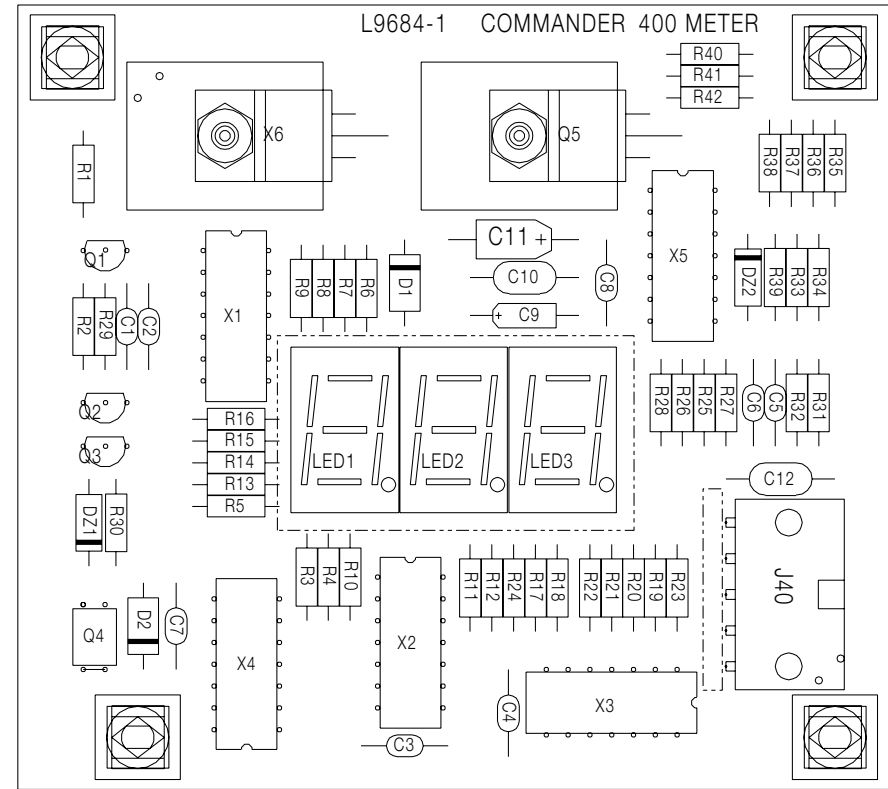
L9596-1  
8-14-98C

SCHEMATIC - METER PC BOARD



NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual.

PC BOARD ASSEMBLY - METER PC BOARD



ITEM	REQ'D	PART NO.	IDENTIFICATION
C 1	1	S 16668-6	4700pF /50
C2, C3, C4, C7, C8	5	S 16668-5	. 022/50
C5, C6	2	S 16668-8	330pF / 100
C9	1	S 13490-95	. 33/50
C 10, C 12	2	S 16668- 11	. 1/50
C 11	1	S 13490-25	4. 7/35
D 1, D2	2	T 12 199- 1	1N4004
DZ 1	1	T 12702-29	1N4744A
DZ2	1	T 12702-27	1N4740
J40	1	S22025-5	CONNECTOR, MOLEX, MI NI , RT-L
LED 1, LED2, LED3	3	S 17395-5	LED DISPLAY
Q 1, Q2	2	T 12704-68	2N440 1
Q3	1	T 12704-69	2N4403
Q4	1	T 12704-73	IC PKG MOSFET ( SS)
Q5	1	T 12704-62	3A, 100V, TRANSISTOR
R 1	1	S 19400-22 11	2. 2 1K 1/4W
R2, R3, R4, R5, R6, R7, R8, R9 R 10, R 11, R 12, R 13, R 14, R 15 R 16, R 17, R 18, R 19, R20, R2 1 R22, R23, R24, R25, R26, R30	26	S 19400- 1000	100 1/4W
R27, R28	2	S 19400-30 11	3. 0 1K 1/4W
R29	1	S 19400-475 1	4. 75K
R3 1, R32, R33, R34, R35, R36 R37, R38	8	S 19400-20R0	20 1/4W
R39	1	S 19400-2000	200 1/4W
R40, R4 1, R42	3	S 19400- 10R0	10 1/4W
X 1, X2, X3	3	S 17900-9	14 PIN I. C. ( SS)
X4	1	S 17900-23	DIG. INTEG. DUAL FLIP-FLOP I. C. ( SS)
X5	1	S 17900-8	14 PIN I. C. ( SS)
X6	1	S 15 128-5	+5V REG.

CAPACITORS = MFD/VOLTS  
RESISTORS = OHMS

L9684-1  
9-27-96F

NOTE: Lincoln Electric assumes no responsibility for liabilities resulting from board level troubleshooting. PC Board repairs will invalidate your factory warranty. Individual Printed Circuit Board Components are not available from Lincoln Electric. This information is provided for reference only. Lincoln Electric discourages board level troubleshooting and repair since it may compromise the quality of the design and may result in danger to the Machine Operator or Technician. Improper PC board repairs could result in damage to the machine.



17948 M

TO "OUTPUT CONTROL SOURCE" SWITCH S6

TO MOTHER CONTROL PCB

TO "REMOTE/LOCAL" SWITCH S1

TO REMOTE CONTROL AMPHENOL

NOTES :

N.A. SINCE COMPONENTS OR CIRCUITRY ON A PRINTED CIRCUIT BOARD MAY CHANGE WITHOUT AFFECTING THE INTERCHANGEABILITY OF A COMPLETE BOARD, THIS DIAGRAM MAY NOT SHOW THE EXACT COMPONENTS OR CIRCUITRY OF CONTROLS HAVING A COMMON CODE NUMBER.

THIS SHEET CONTAINS PROPRIETARY INFORMATION OWNED BY THE LINCOLN ELECTRIC CO. AND IS NOT TO BE REPRODUCED, DISCLOSED OR USED WITHOUT THE EXPRESS PERMISSION OF THE LINCOLN ELECTRIC CO.

UNLESS OTHERWISE SPECIFIED TOLERANCE ON HOLES SIZES PER E-2056 ON 2 PLACE DECIMALS IS + .02 - ON 3 PLACE DECIMALS IS + .002 - ON ALL ANGLES IS + .5 OF A DEGREE MATERIAL TOLERANCE ("I") TO AGREE WITH PUBLISHED STANDARDS

Ch'ge Sht.No.

XA

12-15-95A

THE LINCOLN ELECTRIC CO. CLEVELAND, OHIO U.S.A.

SCALE NONE

DR. BK DATE 5-16-95 CHK. FV SUP'S'D'G. SHT. NO. M 17948

GENERAL INFORMATION

ELECTRICAL SYMBOLS PER E1537

CAPACITORS = MFD (.022/50V UNLESS OTHERWISE SPECIFIED)

RESISTORS = Ohms ( 1/4W UNLESS OTHERWISE SPECIFIED)

DIODES = 1A, 400V (UNLESS OTHERWISE SPECIFIED)

LAST NO. USED

L- 5

C- 5

TP- 4

LABELS

▲ SUPPLY VOLTAGE NET

○ POWER SUPPLY SOURCE POINT

▽ COMMON CONNECTION

FRAME CONNECTION

EARTH GROUND CONNECTION

FILE: M17948\_1AA

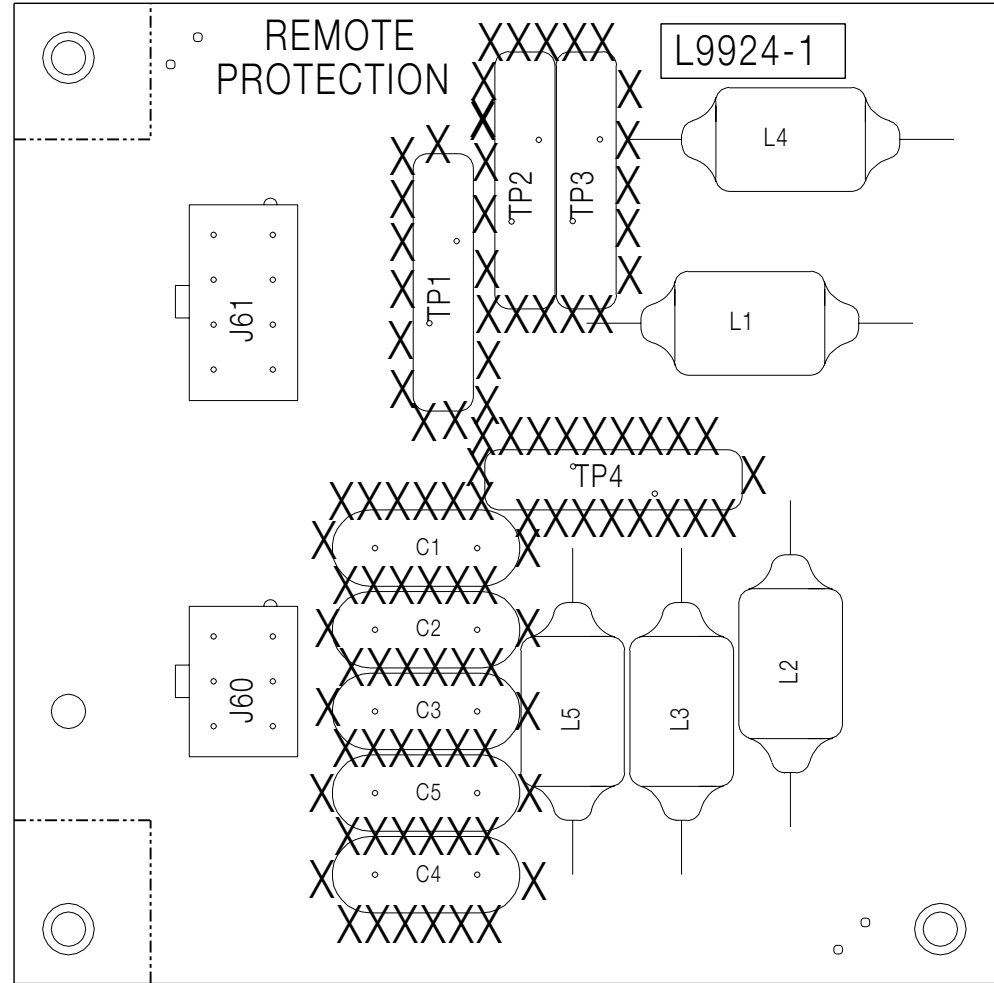
COMMANDER

SUBJECT REMOTE PROTECTION P.C. BD. SCHEMATIC



**COMMANDER 400**

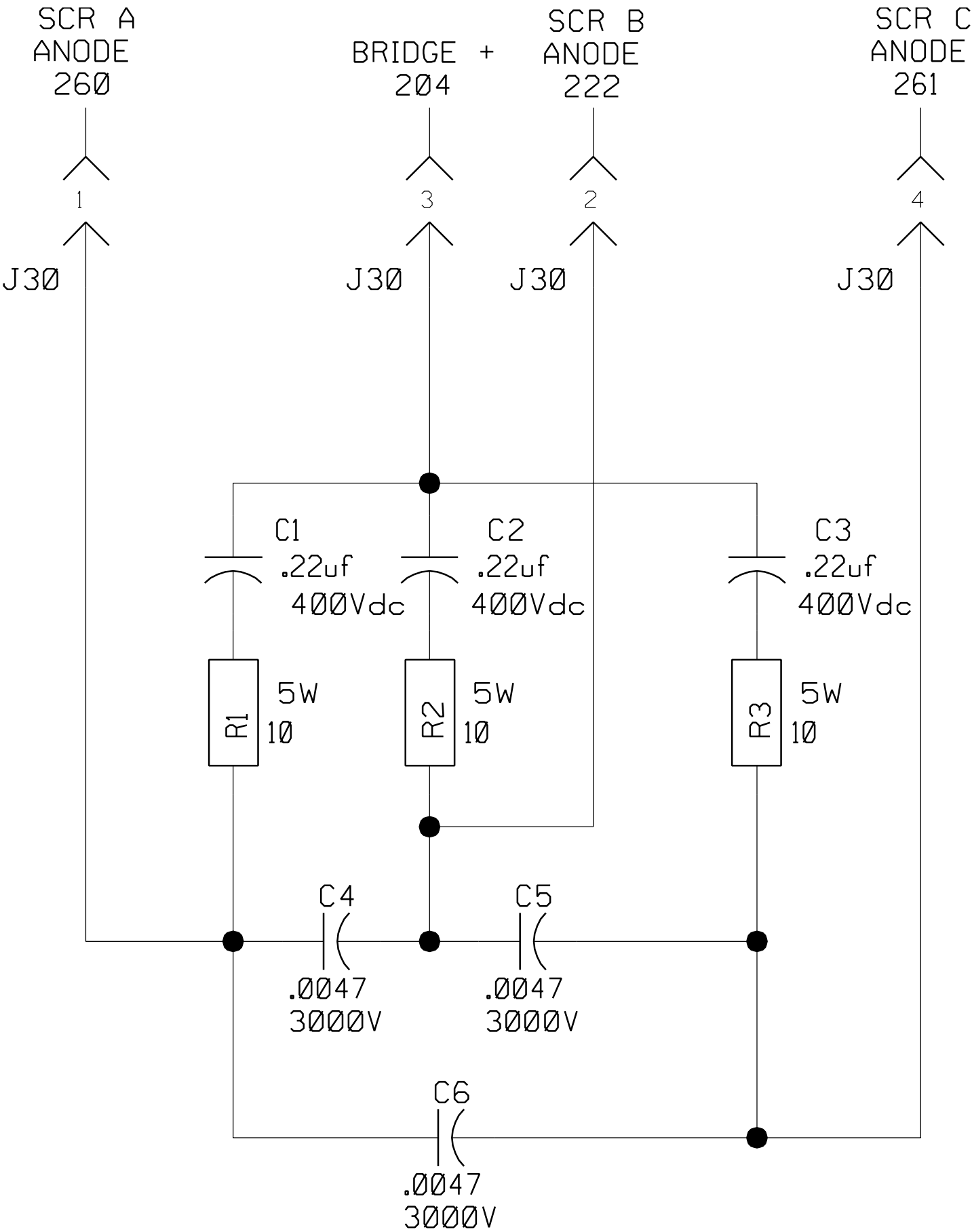
PC BOARD ASSEMBLY - REMOTE PROTECTION PC BOARD



ITEM	ITEM	REQ'D	PART NO.	IDENTIFICATION
C1, C2, C3, C4, C5		5	T11577-58	.0047/3000V
J60		1	S18248-6	HEADER
J61		1	S18248-8	CONNECTOR
L1, L2, L3, L4, L5		5	T12218-9	.39mH
TP1, TP2, TP3, TP4		4	T13640-16	80J

L9924-1  
12-15-95A

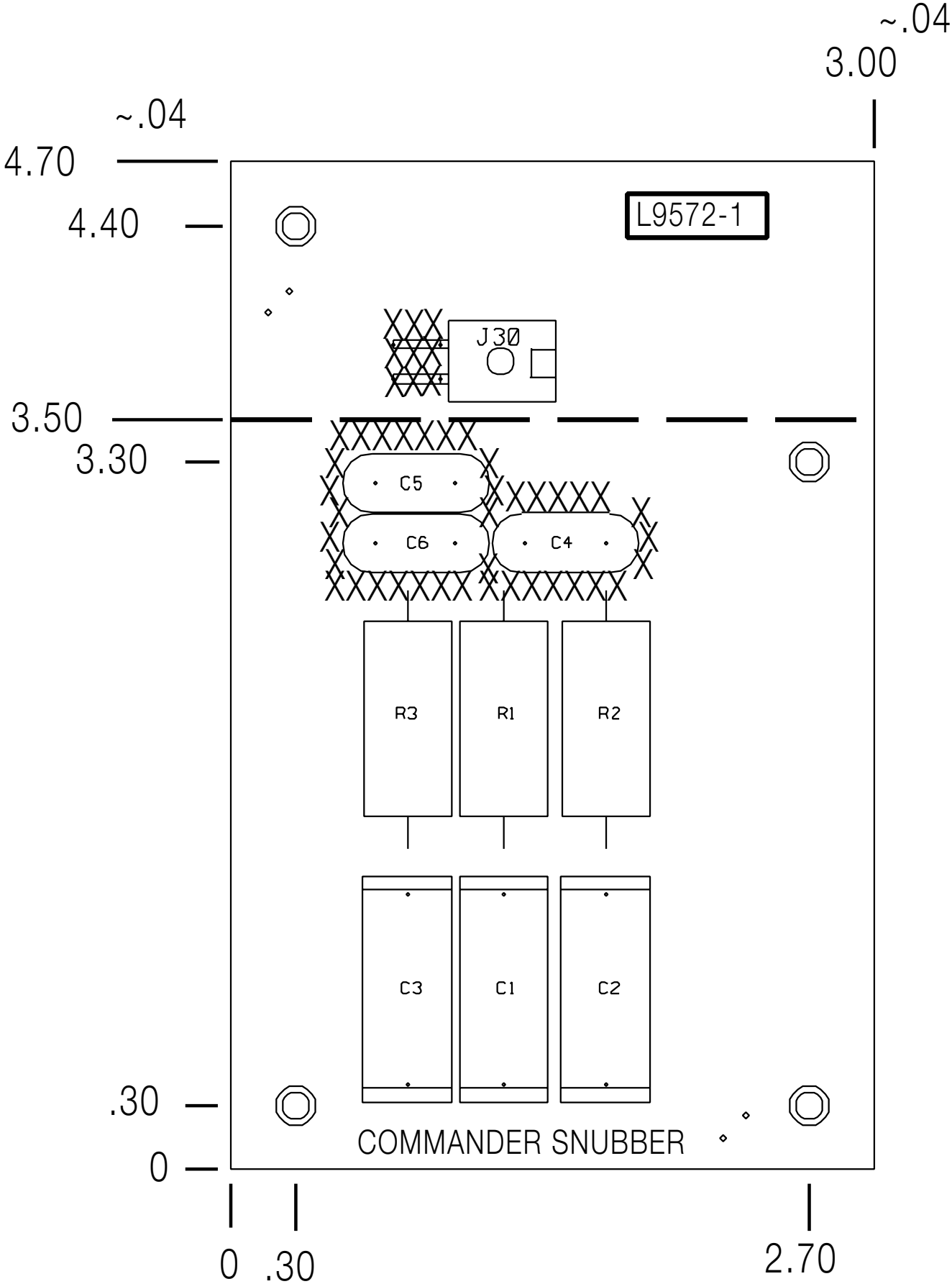
SCHEMATIC - SNUBBER PC BOARD



NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual.

S 21252  
1-16-98E

PC BOARD ASSEMBLY - SNUBBER PC BOARD



ITEM NO.	ITEM	REQ'D	PART NO.	IDENTIFICATION
C1, C2, C3		3	S20500-3	.22/400V
C4, C5, C6		3	T11577-58	.0047/3000V
J30		1	S20351-4	HEADER
R1, R2, R3		3	T14648-25	10 5W

CAPACITORS = MFD/VOLTS  
INDUCTANCE = HENRYS

L 9572-1

12-15-95A  
1-16-96E

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Return to Section TOC	Return to Section TOC	Return to Section TOC
Return to Master TOC	Return to Master TOC	Return to Master TOC

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